

Chapter 2 - Hazards Analysis and Risk Assessment

2.1 Hazards Background

With only a few exceptions, the various natural hazards that might impact the County of Athens at some future time have been the same natural hazards that have historically impacted the County. Barring a major change in weather patterns, extreme weather events will likely occur in a similar fashion as the historic record indicates. There is a lively debate in scientific and policy-making communities about the causes and impacts of global warming. There is data that indicates changes are happening in our weather patterns. Trends seem to indicate more severe or variable weather in terms of rainfall intensity and amounts, wind speed, and temperatures which appear to be on the rise in southeastern Ohio.

A new hazard is now listed for Athens County. The hazard is invasive species and is prompted by its listing in the State Plan Draft for 2019. Invasive species were recognized as a problem in the Athens County Comprehensive Land Use Plan completed in 2010. The problem has only worsened over the past ten years, sometimes with amazing speed. The Emerald Ash Borer was not in Athens County ten years ago and today most Ash Trees in Athens County are dead as a result of its infestation.

When a hazard assessment is performed, it is important to realize that unique and extreme environmental conditions are necessary to create extreme hazards. For instance, widespread flooding conditions are the result of strong low pressure weather systems that bring in large quantities of moist air. The flooding can be made worse if the rain occurs on already frozen ground during a rapid period of snow melt. Occasionally several strong weather systems will pass through an area within days of each other and if each brings large rainfall amounts, the flooding can be made much worse. On a similar note, while highly unlikely in southeastern Ohio, should an earthquake occur when our slip prone soils are already highly saturated, we could be faced with landslides that are larger and more frequent than those to which we are accustomed.

Generally speaking, the more severe or extreme the natural event, the less likely its occurrence because of the unique circumstances required for that extreme event to happen. While any scale tornado in Athens County is rare, a truly large and destructive tornado has never happened and its chances of happening are extremely remote due to topography and weather patterns. While flooding in the County is not uncommon, large floods that cause significant damage are rare and the largest floods that can cause catastrophic damage are extremely rare. We are working with chance events however, large floods can occur in close sequence. This happened to the Village of Amesville, in northeastern Athens County, when a record flood in 1997 was followed by a record flood in 1998 that measured six feet higher than the 1997 flood. Climate change may be creating a situation in which more severe and intense storms lead to results unlike those we have experienced.

With the exception of earthquakes, natural hazards are associated with extreme events of weather. Even landslides require moisture and are more likely to occur after heavy rainfall events. Our climate has much to do with the type and severity of hazards that we face. An excellent book, Thunder in the Heartland, describes Ohio's climate and weather extremes as follows:

"...Ohio is in the middle latitudes, at low elevations, in the eastern interior of North America, and south of the Great Lakes. This location in the Heartland of North America gives Ohio a climate with four distinct seasons, large seasonal temperature ranges, frequent precipitation, and the wide variety of weather so typical of the middle latitudes.

Severe and extreme weather of various sorts are also typical of the Heartland. Temperatures in Ohio have ranged from 113 degrees to nearly -40 degrees. Frosts have blackened corn in July and shirtsleeves weather has prevailed at Christmas. Blizzards have isolated communities for days and flood waters have surged twenty feet deep through the main streets of Ohio's cities....Drought has withered crops, hail the size of baseballs has punched through roofs of homes, and winds have blown lake freighters through bridges, trains off tracks, and homes onto sleeping occupants."³

An initial step with hazard identification is the production of a list of the natural hazards that could occur in Athens County. The list of hazards below, was created through input from the Natural Hazard Mitigation Committee, local public input, research from previous natural hazard disaster events and declarations, and current floodplain maps and risks assessments. The list is alphabetical and not in any particular order of likelihood of occurrence or severity. Pestilence was considered but not included in the list. Pestilence is a natural hazard but the Ohio Department of Health is so equipped to deal with such hazards that pestilence was not included in the scope of this Plan. Also ruled out because environmental conditions make the hazard's occurrence impossible are avalanche, coastal erosion, coastal storm, hurricane, tsunami, and volcano. Dam failure is included, even though it is an event caused by failure of a manmade structure, because such failure will most likely occur during or after a flood event. Due to its growing impact on Athens County, invasive species was added to the list for this update.

Dam Failure

Drought

Earthquake

Extreme Cold

Extreme Heat

Flooding (Flash)

Flooding (Riverine)

Freezing Rain/Ice Storm

Hail

High Winds

Invasive Species

Landslide/Rockfall

Land Subsidence (mines)

³ Schmidlin, Thomas W. and Jeanne Appelhans Schmidlin, *Thunder in the Heartland*, The Kent State University Press, Kent, Ohio, 1996, p.1.

Thunderstorms/Lightning
Tornado
Wildfire
Winter Storms/Blizzard

2.2 Natural Hazard Profiles

The second step with hazard identification is profiling the hazards. Profiling uses historic documentation and currently available information and technology to assess the comparative degree of risk between the various hazards. The spreadsheet in Appendix 9 shows recent information about natural hazards and helps to organize information so that the hazards that pose the greatest risk can be given the most attention in the Plan Mapping is critical for mitigation planning and the Athens County GIS data was utilized to create custom hazard maps for each jurisdiction. These are located later in this chapter.

Each hazard identified by the Planning Committee will be described below. Basic information discussed with each hazard is its location, extent (magnitude/strength), its prior occurrences, and the probability of a future occurrence.

2.2.1 Dam/Levee Failure

Dam failure is defined by the Army Corps of Engineers as “any condition resulting in the uncontrolled release of water other than over or through a spillway or outlet works.”⁴ While dam failure is a highly unlikely event it is still possible and any natural hazard plan needs to consider it. The SOHMP 2019 Draft Plan lists 8 reasons dams can fail. Dam failures can result from any one or a combination of the following causes:

- Prolonged periods of rainfall and flooding;
- Inadequate spillway capacity, resulting in excess overtopping flows;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost materials from the cross section of the dam and abutments, or maintain gates, valves, and other operational components;
- Improper design including the use of improper construction materials and construction practices;
- Improper operations, including the failure to remove or open gates or valves during high flow periods;
- Failure of upstream dams on the same waterway that release water to a downstream dam;
- Earthquakes, which typically cause longitudinal cracks at the tops of the embankments that can weaken entire structures.

Dam Failure: Any condition resulting in the uncontrolled release of water other than over or through a spillway or outlet works.

⁴ Burr Oak Inundation Plan and Map, U.S. Army Corps of Engineers

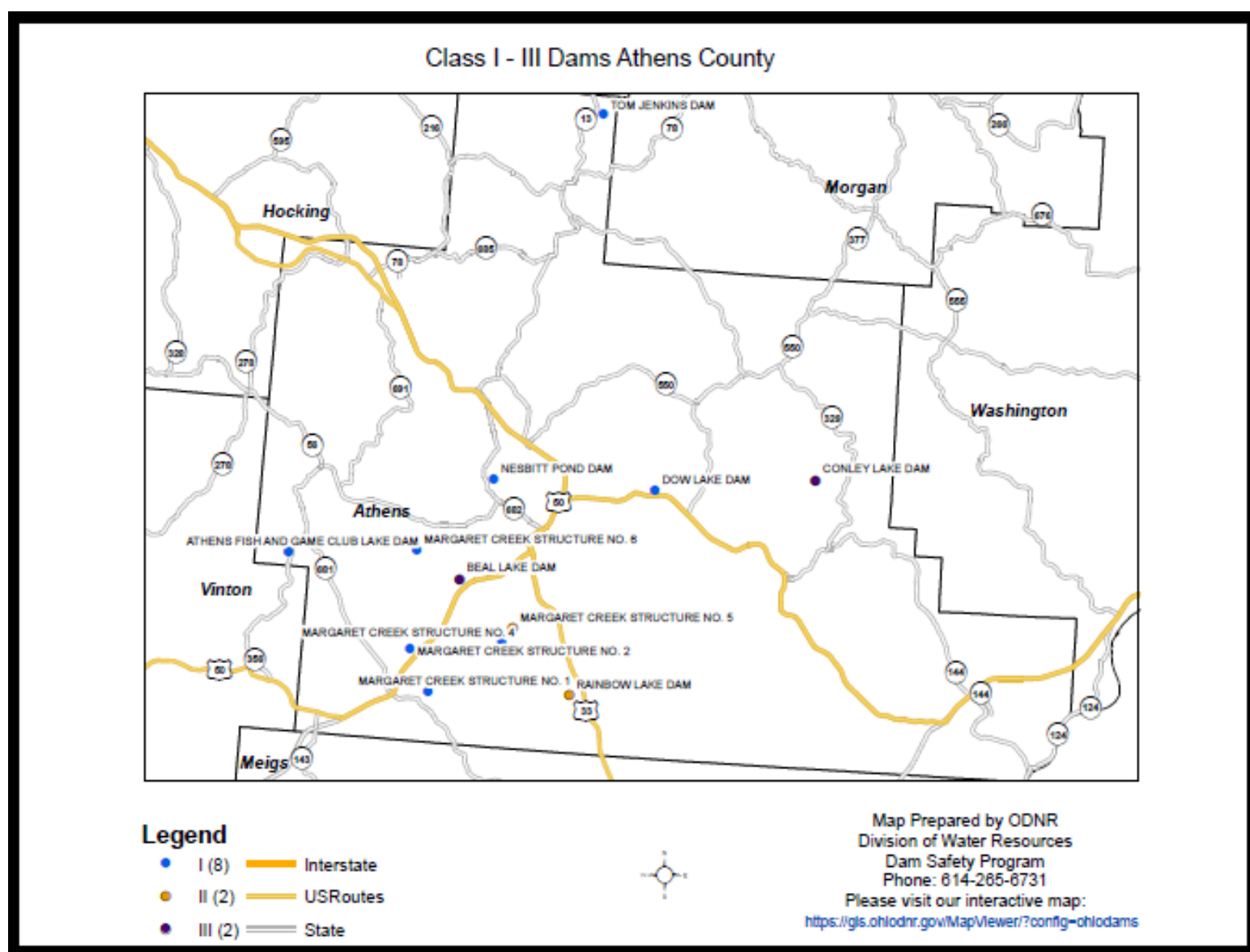
Dams are designed with emergency spillways that allow for a controlled overtopping of the structure. In this way damage to the structure is non-existent or greatly reduced. However, should a dam fail, the damage below it can be far-reaching and severe. Dam and levee failure are location specific hazards in that those assets within the inundation area will be most affected. The Ohio Dam Safety Program rates dams as follows:

Class I:

Dams having a total storage volume greater than five thousand acre-feet or a height of greater than sixty feet shall be placed in class I. A dam shall be placed in class I when sudden failure of the dam would result in one of the following conditions.

Probable loss of human life

Structural collapse of at least one residence or one commercial or industrial business



Map 3 Class I-III Dams of Athens County

Class II:

Dams having a total storage volume greater than five hundred acre-feet or a height of greater than forty feet shall be placed in class II. A dam shall be placed in class II when sudden failure of the dam would result in at least one of the following conditions, but loss of human life is not probable.

Disruption of a public water supply or wastewater treatment facility, release of health hazardous industrial or commercial waste, or other health hazards

Flooding of residential, commercial, industrial, or publicly owned structures

Flooding of high-value property

Damage or disruption to major roads including but not limited to interstate and state highways, and the only access to residential or other critical areas such as hospitals, nursing homes, or correctional facilities as determined by the chief

Damage or disruption to railroads or public utilities

Damage to downstream class I, II or III dams or levees, or other dams or levees of high value.

Damage to dams or levees can include, but is not limited to, overtopping of the structure

Class III:

Dams having a total storage volume greater than fifty acre-feet or a height of greater than twenty-five feet shall be placed in class III. A dam shall be placed in class III when sudden failure of the dam would result in at least one of the following conditions, but loss of human life is not probable.

Property losses including but not limited to rural buildings not otherwise described in paragraph (A) of this rule, and class IV dams and levees not otherwise listed as high-value property in paragraph (A) of this rule. At the request of the dam owner, the chief may exempt dams from the criterion of this paragraph if the dam owner owns the potentially affected property

Damage or disruption to local roads including but not limited to roads not otherwise listed as major roads in paragraph (A) of this rule

Class IV:

Dams which are twenty-five feet or less in height and have a total storage volume of fifty acre-feet or less may be placed in class IV. When sudden failure of the dam would result in property losses restricted mainly to the dam and rural lands, and loss of human life is not probable, the dam may be placed in class IV. Class IV dams are exempt from the permit requirements of section 1521.06 of the Revised Code pursuant to paragraph (C) of rule 1501:21-19-01 of the Administrative Code.

Map 3 shows the locations of Class I-III dams in Athens County. Five of the twelve Class I-III dams are privately owned.

The SOHMP 2019 also states, "In terms of emergency management, dam failures are categorized as either sunny day failures or rainy day failures. Sunny day failures occur during a non- flooding situation with the reservoir near normal pool level. Rainy day failures usually involve periods of rainfall and flooding, and can exacerbate inadequate spillway capacity. Improper design of a spillway or operation of gates during high flows can lead to excessive water pressure and subsequent failure as well. Even though both types of failures can be disastrous, it can be assumed that a sunny day failure would be more catastrophic due to its unanticipated occurrence and the lack of time to warn residents downstream."

Acre-foot: An amount of water one acre in extent and one foot deep or approximately 326,000 gallons.

Inundation maps show the areas impacted if a dam should fail. Inundation maps are produced with three scenarios: 1. A sunny day failure as described above, 2. A failure during the occurrence of a 1%-chance flood, and 3. A failure during the occurrence of the probable maximum flood.

There are several impounded water bodies in Athens County that could have an effect on downstream areas were one or several of the dams holding this water to fail. The large water bodies are Burr Oak Lake, Dow Lake, and the lakes that make up the Margaret Creek Conservancy District. The Margaret Creek Conservancy lakes are Meeks Lake, Lake Snowden, site number 4, site number 5, and Fox Lake. Other class 1 dams are the Athens Fish and Game Club Lake Dam, the Nesbitt Pond Dam, and the Rainbow Lake Dam. The Burr Oak dam is managed by the Corps of Engineers, the Dow Lake dam is managed by the Ohio Department of Natural Resources, Division of Water Dam Safety Section, the Lake Snowden dam is managed by Hocking College, the Game Club, Nesbitt Pond, and Rainbow Lake dams are private, and the Margaret Creek Conservancy District manages the remaining four lakes. The Margaret Creek Conservancy District is managed by the Hocking Conservancy District and both are organized as Conservancy Districts under Ohio law.

Probable Maximum Flood: Flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that is reasonably possible in the drainage basin.

Burr Oak Lake, impounded by the Tom Jenkins Dam located in Athens County, Dow Lake, and Lake Snowden in southwestern Athens County could have serious effects on downstream areas should the dams fail. These dams are rated Class I. According to the ODNR, dams in Ohio have been divided into four classes; I, II, III, and IV based upon downstream threat potential. The failure of a class I dam will likely result in loss of life and pose a serious hazard to health and property in the inundation area. A class I dam has a volume capacity over five thousand acre-feet or a height greater than sixty feet. Exempt from Ohio's regulatory authority are dams less than six feet in height regardless of storage volume, dams less than 10 feet in height with not more than 50 acre-feet of storage, or not more than 15 acre-feet of total storage regardless of height.

During a heavy rainfall event in March 1997, water flowed over emergency spillways at Meeks Lake, site #4, and site #5. Subsequent to the 1997 floods, the dam at Lake Snowden was elevated to what is considered a “100% level”. According to Scott Jerome, a planning engineer with the Natural Resource Conservation Service, a dam at this level is capable of holding 24”-28” of rainfall in an eight hour period. This is more than twice the amount of rainfall that has historically fallen in the Athens area.

For comparison, the 1% chance flood at this cross section is 642 feet, so a dam failure on Burr Oak Lake when the spillway is already flowing at capacity could bring an additional five feet of water to the City 24 hrs. 30 mins. after the failure.

Inundation maps were produced for the Margaret Creek Conservancy lakes, Dow Lake, and for Burr Oak Lake. The inundation map for Margaret Creek does not contain flood elevations but a comparison between it and the FEMA 1% chance flood map indicates that the inundation area affected is significantly larger than the 1% chance floodplain along some reaches of the Creek. The Burr Oak Flood Emergency Plan for the Tom Jenkins Dam calculated floodwater arrival times, peak flood times, and water elevations at various cross sections on the Hocking River from Nelsonville to Guysville in the events of a spillway design flood and dam failure. The spillway design flood is defined by the Corps of Engineers as “the maximum flow which a dam’s spillway is designed to pass safely.” At cross section #36, the location of the Convocation Center on Ohio University’s campus, the following data was provided:

Table 3 Excerpt Burr Oak Flood Emergency Plan for Tom Jenkins Dam

	Spillway Design Flood	
	Without Dam Failure	With Dam Failure
Arrival Time	30 hrs. 00 mins.	11 hrs. 15 mins.
Peak Flood Time	45 hrs. 30 mins	24 hrs. 30 mins.
Peak Elevation	638.0 feet	647.0 feet

The disastrous effects of a dam failure are obvious when analyzing the peak elevations below the dam and explain why dam inspection and maintenance is such a big priority in Ohio. With the exception of the Tom Jenkins Dam, ODNR has inspection responsibilities for the Class I-III dams. ODNR inspected The Athens Fish and Game Club Dam in 2016 and the remaining Class I-III dams in 2017. A detailed repair was made to the Dow Lake Dam in 2014.

The Hocking Conservancy District manages a levee through the City of Athens. It is responsible for approximately five miles of a flood control project built by the Corps of Engineers in the early 1970’s. The Conservancy District receives ongoing maintenance expertise from the Corps. The portion that flows through Ohio University lands between the Richland Avenue Bridge and the US Rt. 33 Bridge has three gated pumping stations that will operate during extremely high flows. The levee has never been overtopped in this area but residents and officials need to realize it is not designed for even the 1% chance flood and climate change may test its limits. Ongoing education and emergency plans need to be continually updated and refreshed.

Based on diligent inspection by the state and federal government and their being no evidence of significant past dam failure, the likelihood of a future dam failure is rare. However, based upon past flood events and that the flood control levee through the City of Athens is not designed for a 1% chance flood, it is likely that it will be overtopped by flood waters.

2.2.2 Drought

Drought is a normal, recurrent feature of climate. In general, a drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector. This deficiency is often the result of a persistent high pressure that lowers humidity, precipitation and cloud cover and blocks moisture from entering the region. Droughts are slow, coming without warning over several weeks. They can effect vegetation, crops, and the water supply and can contribute to extreme heat events and wildfires.

The Palmer Drought Severity Index (PDSI) is a soil moisture algorithm used to measure the drought intensity. The PDSI was developed by W.C.Palmer in 1965. Many U.S. government agencies and states rely on the PDSI to trigger drought relief programs and responses. Most of the agency-based actions within the Ohio Emergency Operation Plan's Drought Incident Annex are triggered by the PDSI. The classifications run from a rating of 4.0 or greater as extremely wet to a rating of -4.0 or less as extreme drought. There are a total of 11 classifications with this system.

The SOHMP 2019 states, "Within the State of Ohio, drought is equally as possible to occur in one section of the state as it is in another. The effects of drought within the state vary though, based on land use (agricultural production as opposed to urban areas), economy (dependence on drought-impacted business such as farming), geology (presence of an aquifer or ground structure that limits well production), and water source (public water supply, private well, or cistern). There are four primary types of drought: agricultural, hydrological, meteorological, and socioeconomic. The State of Ohio is most often affected by agricultural and hydrological types of drought, and is often affected by both simultaneously."

Predicting drought is difficult because it relies on forecasting so many variables, primarily temperature and precipitation. Drought in Ohio has been recorded since 1895 using the Palmer Hydrological Drought Index (PHDI). Since then, six great Ohio droughts have occurred in 1895, 1930-31, 1934, 1953-54, 1963-64, and 1988.⁵

On July 30, 2012, the Governor of Ohio sent a memorandum to the USDA Ohio State Executive Director requesting primary county natural disaster designations for eligible counties due to agricultural losses caused by drought and additional disasters during the 2012 crop year. The USDA reviewed the Loss Assessment Reports and determined that there were sufficient production losses in 85 counties to warrant a Secretarial disaster designation. On September 5, 2012, Athens County was one of those designated counties.

⁵ Schmidlin, p. 147.

A review of NCDC Palmer drought indices for 2014-February 2018 in Ohio indicates that drought was not an issue. 2016 was the driest year during this period with the index dropping below -1.0 for three of the months. Additional precipitation data that is available for Athens County comes through the Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS). According to its website, “CoCoRaHS (pronounced KO-ko-rozz) is a grassroots volunteer network of backyard weather observers of all ages and backgrounds working together to measure and map precipitation (rain, hail and snow) in their local communities. By using low-cost measurement tools, stressing training and education, and utilizing an interactive Web-site, our aim is to provide the highest quality data for natural resource, education and research applications.” Precipitation data gathered in the City of Athens by the CoCoRaHS County Coordinator for the period 2010-2018 was:

Table 4 Community Collaborative Rain, Hail, and Snow Network

Year	<i>Precipitation Amount</i>	Year	<i>Precipitation Amount</i>
2010	45.42 in.	2015	45.79 in.
2011	48.00 in.	2016	34.05 in.
2012	40.76 in.	2017	39.13 in.
2013	39.51 in.	2018	53.37 in.
2014	33.77 in.		

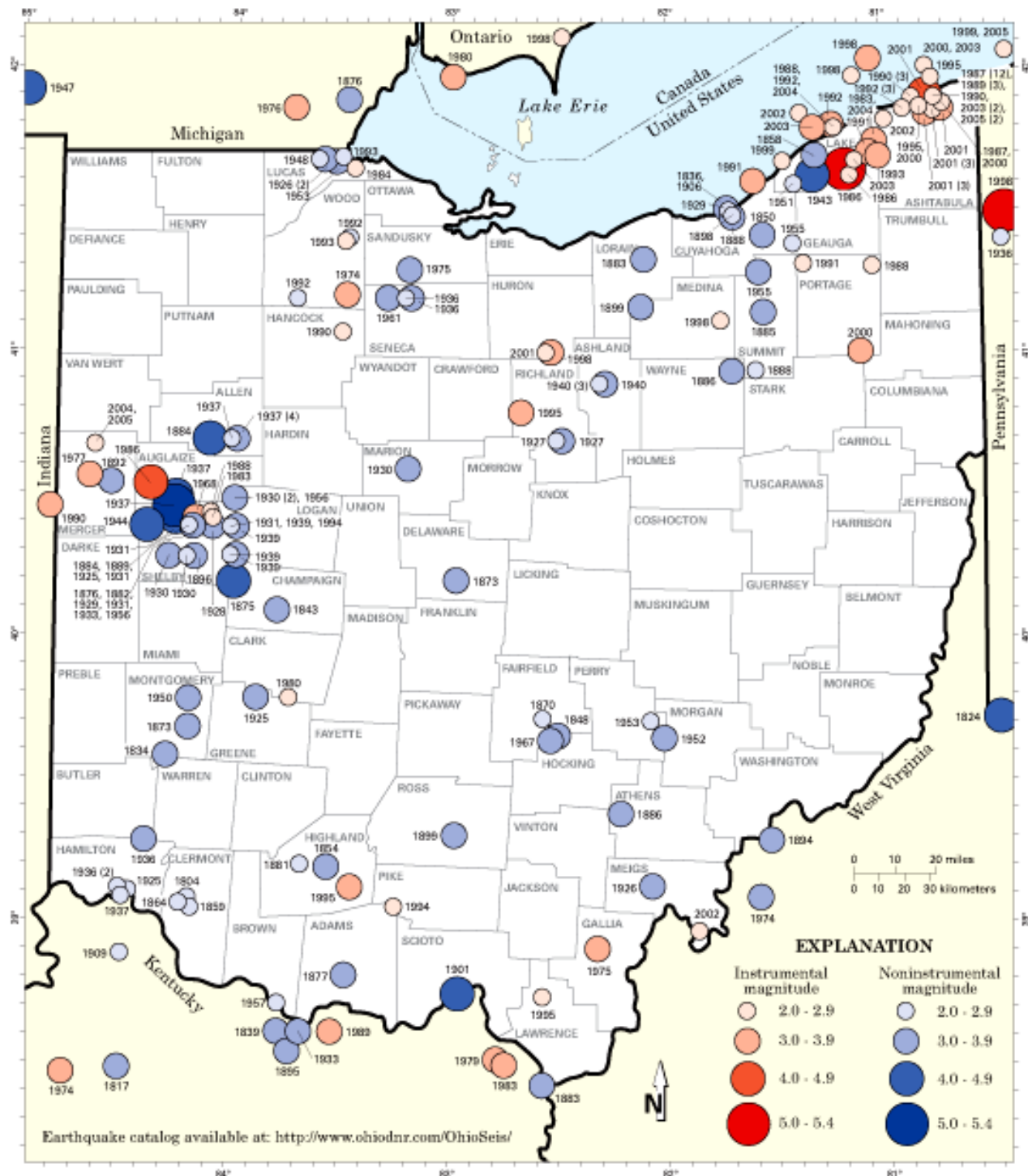
The precipitation data gathered by the CoCoRaHS Coordinator for the period 1/1/2019 to 9/4/2019 is 32.85 inches. The very wet year of 2018 had 53.37 inches of precipitation, so 2019 appears to be wetter than average so far. The NCDC Palmer Hydrological Drought Index for June 2019 showed southeastern Ohio to be extremely moist with an index of +4.00 and above.

Drought will affect all areas of Athens County. Based upon historical records of drought, it is likely that a drought will occur over the span of several decades and likely that a severe drought will occur when a long time span of many decades is assumed.

Drought: A deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector.

2.2.3 Earthquake

Athens County has a relatively low susceptibility to severe and damaging earthquakes. Both a low Peak Ground Acceleration (PGA) and only a single recorded earthquake occurring in 1886 characterize it. According to the United States Geological Survey, Athens County has Peak Ground Accelerations (PGA) ranging from approximately 2.53 %g to approximately 2.70 %g with a 10% chance of being exceeded over 50 years. The PGA is a measurement of the strength of ground movements and is used to determine the maximum severity of an earthquake. The PGA



Map 4 Earthquake Events of Ohio

for Athens County means that the maximum severity of an earthquake will be relatively small (2.53 %g – 2.70 %g) with a 10 % chance of an earthquake exceeding this severity over 50 years. The USGS Peak Acceleration map also shows Athens County to have dark gray shading, coinciding with a PGA between 2 and 3%g with 10% chance of exceedance in 50 years.

Athens County's low PGA is consistent with the history of earthquakes in the county.

Geo Facts, by the Ohio Department of Natural Resources, Division of Geological Survey identifies Southeast Ohio as "particularly susceptible to seismic activity." Ten earthquakes have occurred in the area, with minor to moderate damage occurring in Scioto, Meigs, and Perry County. A map also identifies an Athens County earthquake as occurring in 1886. It shows the earthquake's intensity to be between IV and VI on the Modified Mercalli Scale. A level VI earthquake, the most extreme possible level of the 1886 earthquake is characterized as follows: "Felt by all, many frightened and run outdoors; falling plaster and chimneys, damage small."

According to the National Climactic Data Center earthquake hazard map, there were no significant earthquake events in recorded history centered near Athens County. The Significant Earthquake Database contains information on destructive earthquakes from 2150 B.C. to the present that meet at least one of the following criteria: Moderate damage (approximately \$1 million or more), 10 or more deaths, Magnitude 7.5 or greater, Modified Mercalli Intensity X or greater, or the earthquake generated a tsunami.

The earthquake hazard affects all areas of Athens County. Based upon past occurrences of earthquakes, it is unlikely that Athens County will experience a large and damaging earthquake.

Earthquake: An earthquake is the shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves.

2.2.4 Extreme Cold

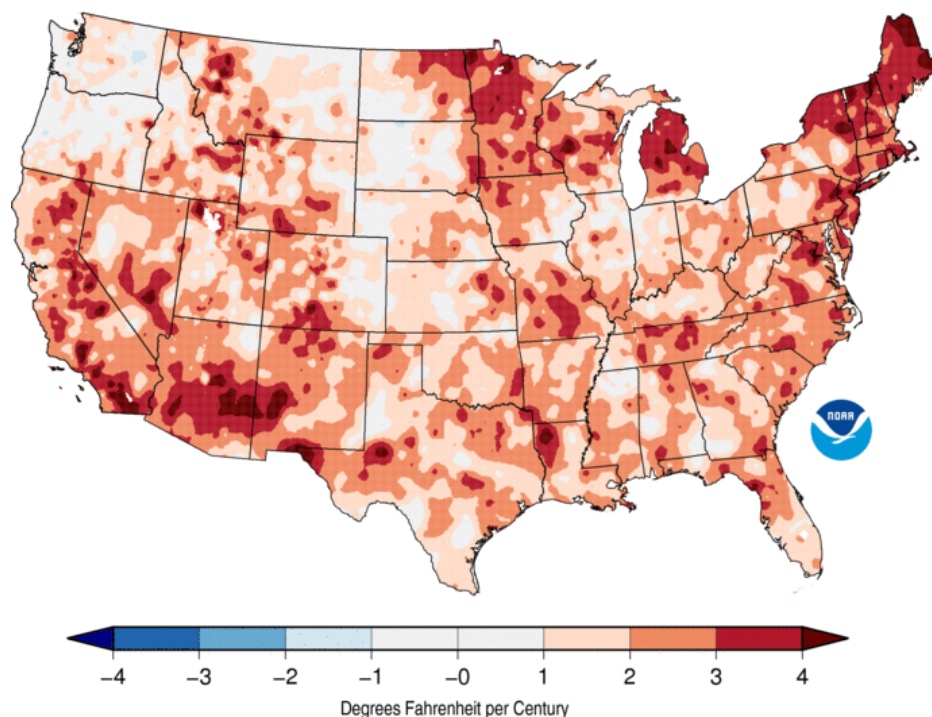
The lowest temperatures in the wintertime come with arctic air masses from Canada. The coldest temperatures occur after a low pressure storm system has passed and left a fresh covering of snow. Arctic air follows as a high pressure system and centers itself in the Midwest. Clear skies will allow heat to radiate to space and the snow cover serves as an insulator between the warmer earth and the colder air.⁶

The state's coldest temperatures are not in the north, but in the valleys of southern and central Ohio. The hilly topography allows cold air to settle in valleys and some of these areas are far enough away from the temperature moderating effects of the Ohio River. The official record cold temperature for Ohio was -37° F set in 1912 near New Lexington in Perry County. January 19, 1994 was the greatest cold wave in Ohio when a greater part of the state registered -25° F or less than at any previous time on record. There were unofficial temperature readings of -40° F in Athens County.⁷

⁶ Schmidlin,

⁷ Schmidlin,

Average Minimum Temperature Trends Annual 1989–2018 (30 years)



Data Source: 5km Gridded Dataset (nClimGrid)

National Centers for
Environmental Information

Map 5 Average Minimum Temperature Trends

The NCDC data from 2014–2018 showed four separate incidents of cold weather that were called in by trained spotters. There was no property damage or deaths or injuries listed for these cold weather events. This hazard can affect all areas and jurisdictions in the County. Based upon the climate record for Athens County, it is likely that Athens County will experience extreme cold.

2.2.5 Extreme Heat

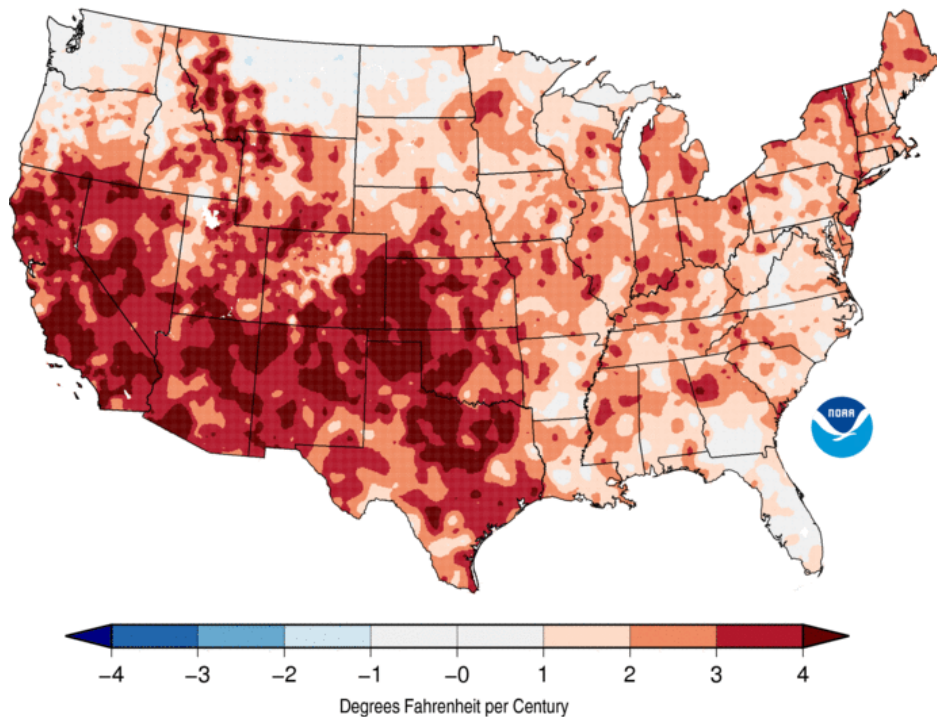
According to FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region, last for prolonged periods of time, and are often accompanied by high humidity that the body cannot tolerate. Extreme heat in Ohio, with temperatures of 110 degrees or more can have a disastrous effect on the state.

A necessary condition for extreme heat in Ohio is a Midwest drought. Soils and vegetation are dry during these droughts, allowing the hot, dry air from the Southwest to enter Ohio without the cooling effects of evaporation. Ohio heat waves are most severe in Southern Ohio, while the Northeast is tempered by the cooler waters of Lake Erie.⁸

Extreme heat in Southeastern Ohio can have widespread effects on human health, energy use, vegetation and crops, and the behavior of materials. In addition to the high temperatures, the duration of a heat wave plays an important role in how people are affected. When extreme heat periods last more than two days, an increase in these effects occurs. Specific populations in Athens County that are at a high health risk during periods of extreme heat include the elderly, young children, isolated individuals, people without access to air-conditioning, and those with respiratory difficulties.

⁸ Schmidlin, p. 129.

Average Maximum Temperature Trends Annual 1989–2018 (30 years)



Data Source: 5km Gridded Dataset (nClimGrid)

National Centers for
Environmental Information

Map 6 Average Maximum Temperatures Trends

1934 summer heat wave. On July 21, 1934 Gallipolis recorded a temperature of 113 degrees, the hottest temperature ever recorded in Ohio. Southeast Ohio also experienced extreme heat periods in July of 1936, August of 1947, August of 1983, and June of 1988.¹⁰

Map 6 shows average annual maximum temperature trends and they appear to be increasing although it must be pointed out that the 30-year data is relatively short term and the trend data for years 1895-2018 does not indicate such an increase.

Extreme heat can affect all areas and jurisdictions in the County. Based upon past records and a warming climate, it is likely that Athens County will experience extreme heat at some time.

Extreme Heat: Temperatures that hover 10 degrees or more above the average high temperature for the region, last for prolonged periods of time, and are often accompanied by high humidity that the body cannot tolerate.

⁹ Schmidlin, p. 131.

¹⁰ Schmidlin, pp. 133-146.

2.2.6 Flooding

The flood hazard is broken into two types of flooding, flash and riverine.¹¹ Before discussing the particulars of each type of flooding, some background information about flooding, in general, is warranted. Flooding is the phenomenon of drainageways (creeks, runs, streams, tributaries, branches, forks, and rivers) receiving more water runoff than they can contain within their banks. As water flows over the waterway's banks it occupies low lying areas, known as floodplains, adjacent to the waterway. The magnitude of floods is measured by their frequency interval or how often they occur, at that magnitude, on average. A large flood that only occurs, on average, once every 100-years is known as a 1% annual chance flood. A flood of this magnitude has a 1% chance of occurring in any given year.

It takes unique climatic circumstances to create large-scale flooding on major streams and rivers. Contributing factors can include already saturated soils, snowmelt, and intense rainfall. The intense rainfall comes from strong, low pressure weather systems that can occur in quick succession.

Larger waterways on more gently sloped land have larger watersheds and it takes longer for the flood to reach its peak level. This leads to what this Plan terms a slow riverine flood. Smaller watersheds in steeper terrain will drain faster and the streams will therefore rise more quickly and fall more quickly. Water velocity will also be greater on more steeply sloped terrain. The rapid rise of high velocity water leads to what is termed a flash flood. These floods can be dangerous because of the force of the rushing water and because there is little to no warning before they hit. The largest natural disaster to impact the state of Ohio was a flood in the spring of 1913. While no part of the state was spared, the greatest impact was felt in the southwestern and west-central portions of the state. Two strong storm systems came through the same geographic areas only two days apart. According to Thunder in the Heartland, a total of 467 persons lost their lives. "Never before 1913, and never since, has so much rain fallen over so much of the state in such a short time." The Flood of 1913 set the record water levels on many Ohio streams.¹²

Southeastern Ohio and Athens County were spared the worst of the flooding from the storms of March 1913. While flooding was severe in 1913, other storms have brought higher flood levels in southeastern Ohio. The largest flood on the Hocking River occurred in March 1907 with other large floods occurring in 1873, 1884, 1937, 1945, 1963, 1964, and 1968. The 1968 flood is

Flood: A flood is a natural occurrence when streams or lakes overflow their banks and spill onto the adjoining land area, which is called a floodplain.

¹¹ In its Hazard Analysis and Risk Assessment, the Ohio EMA breaks floods into four categories: riverine, flash, urban and small stream, and coastal. For simplicity, this Plan will combine flash flooding with urban and small stream flooding under the title of "flash flooding." Since Athens County does not have a Lake Erie coastline, coastal flooding is not an issue.

¹² Schmidlin, p. 172.

considered to be the 1% annual chance flood for the Hocking River and is the second largest historic flood that the Hocking River valley has seen.¹³

Athens County qualified for natural disaster assistance in 2012 due to being contiguous with counties experiencing excessive rain, flooding and flash flooding in May 2-4, 2012. Since the NHMP 2014, Athens County and its jurisdictions qualified for state and federal disaster assistance for three periods of heavy precipitation and flooding:

- Grant 4360, a presidential declaration for flooding that occurred February 14-25, 2018. \$1,903,163.57 was awarded to ten government entities for repairs to roadways.
- SDRP-0217, state disaster assistance for flooding that occurred in February and March 2017. \$440,789.64 was awarded to two government entities for repairs to roadways.
- SDRP-18, state disaster assistance for flooding that occurred in June 2018. \$31,752.25 was awarded to two government entities for repairs to roadways.

Historically, damages from flooding in Athens County have amounted to well over six million dollars.¹⁴ This places flooding as Athens County's most costly hazard for property damage. Riverine flooding is specific to larger drainages with more extensive floodplains. Flash flooding can occur in small drainages and often occur in areas that are not shown as areas prone to flooding on the FEMA flood maps. Flash flood can occur quickly and with smaller scale weather systems and are therefore more frequent than riverine floods. Their geographical extent is also broader than that of riverine floods. The probability of future events is high for both types of flooding and extremely high for flash flooding somewhere within Athens County on a fairly regular basis.

2.2.6.1 Flooding (Flash)

The National Weather Service website states, "Flash Flooding can be caused by a number of things, but is most often due to extremely heavy rainfall from thunderstorms. Flash Floods can occur due to Dam or Levee Breaks, and/or Mudslides (Debris Flow).

The intensity of the rainfall, the location and distribution of the rainfall, the land use and topography, vegetation types and growth/density, soil type, and soil water-content all determine just how quickly the flash flooding may occur, and influence where it may occur.

Urban Areas are also prone to flooding in short time-spans and, sometimes, rainfall (from the same storm) over an urban area will cause flooding faster and more-severe than in the suburbs or countryside. The impervious surfaces in the urban areas do not allow water to infiltrate the ground, and the water runs off to the low spots very quickly.

Flash Flooding occurs so quickly that people are caught off-guard. Their situation may become dangerous if they encounter high, fast-moving water while traveling. If people are at their homes or businesses, the water may rise quickly and trap them, or cause damage to the property without them having a chance to protect the property."

¹³ U.S. Army Corps of Engineers, *Floodplain Information, Hocking River, Athens, Ohio*, January, 1972, p. 20.

¹⁴ National Climatic Data Center, a summary of severe weather events.

Athens County witnesses flash flooding frequently. Intense thunderstorms will bring creek water out of its banks on an annual basis somewhere in Athens County. Fortunately, the majority of these incidents are inconvenient nuisances at worst. Occasionally, such as occurred in 1997 and 1998, intense thunderstorms will drop significant rainfall amounts in sub-watersheds of the Hocking River. These Hocking River tributaries can rise quickly and with little to no warning. On tributaries as large as Federal Creek and on many smaller tributaries there were reports of “a wall of water” advancing on the homes and towns.

Even the lower Hocking River is prone to rapid rise such as what occurred in the June 1998 flood. The tributaries of the lower Hocking received such intense rainfall that the lower Hocking River exhibited flash flood characteristics. This flood happened at night and there was little to no time for people to remove property from the recreational vehicle camps on the lower Hocking. Fortunately, no lives were lost in Athens County during this flood.

Flash flooding is specific to drainageways that possess characteristics that allow them to have rapid water rise, often accompanied by swift flowing waters. The NCDC storm event database included eight separate flash flood events between 2014 and 2018 causing an estimated \$52,000 in property damage¹⁵. No deaths or injuries were associated with these events. Not all areas of the County are prone to flash flooding. Identifying flash flood areas with more precision using GIS is an activity in the County’s five year natural hazard mitigation plan.

Flash Flood: A flood that begins within 6 hours, and often within 3 hours, of the heavy rainfall (or other cause).

2.2.6.2 Flooding (Riverine)

The flood of 1907 was the highest flood on the Hocking River. “Fire bells began ringing in the Hocking Valley to warn of the impending flood on Wednesday, March 13th. The Athens Journal reported a great flood along the Hocking with several lives lost and a wide disruption of communication and transportation. Dozens of homes in Athens were swept away, overturned, or lifted off foundations. Telephone and telegraph wires were down and the waterworks and electric lights plants were flooded. Rail lines all along the Hocking were cut by the raging river. Large areas of Athens were inundated, causing large losses among business and railroads.....Several commercial buildings at Gloucester (Glouster) were lifted and washed away by Sunday Creek, including three grocery stores, a restaurant, and Will Reese’s poolroom, according to the Athens Journal. Many homes and other businesses were damaged. The coal mines around Gloucester

¹⁵ The reports for the NCDC storm database are typically made by one of several sources: Dept. of Highways, 911 Call Center, trained weather observers, river/stream gauges, social media, broadcast media, the FAA’s Automated Weather Observing System, law enforcement, or the post office.



Figure 1 Flood from the Hocking River in 1907

flood level was the highest since 1907.¹⁷

Two heavy rain periods within five days of each other brought flooding to the Hocking River valley between May 23rd and May 27th in 1968. Three to six inches of rain fell on already saturated soils on May 23rd-24th. The Hocking River reached flood stage on May 24th.¹⁸ The rapid rise of waters from this flood prevented residents from moving personal belongings out of harm's way. Even though riverine flooding happens more slowly than flash flooding, it is apparent that floodwaters on the Hocking River can still rise rapidly enough to catch people off guard.

suffered heavy losses. Mine 256 was flooded, resulting in the loss of thirteen horses, machines, motors, cars, and other equipment. All homes in Trimble were flooded.”¹⁶

As much as 8 inches of rain fell in the Hocking River watershed during 4-10th March 1964 and brought major flooding to Athens County. The Hocking River crested in Athens on March 11 at 24.15 feet. The

¹⁶ Schmidlin, pp. 170-171.

¹⁷ “Athens County schools dismissed early to allow buses to deliver children home before roads were flooded by rising rivers, and Ohio University students removed their cars from basement garages at West Green dormitory. National Guard troops, firemen, and police worked through the night to evacuate residents of Rockbridge and South Logan upstream along the Hocking River.....All schools and main highways were closed in the region on Wednesday, mail delivery was curtailed, fifteen hundred Ohio University students were evacuated, and 380 Athens homes were flooded, according to the *Athens Messenger*.” (from Schmidlin, p 208.).

¹⁸ “The Hocking River reached 24.63 feet at Athens, more than 7 feet above flood stage and the highest since 1907. All communities along the Hocking were flooded, and roads, schools, businesses, and factories were closed throughout the river basin. Amesville businesses were flooded and for the first time in memory, there was water on the floor of the First National Bank Building. Three feet of water in Amesville Nursing Home forced residents to the second floor. The *Athens Messenger* reported that a helicopter delivered food to the stranded nursing-home residents. Homes were evacuated and highways blocked in Nelsonville, Murray City, Logan, Rockbridge, and Chauncey. The quick overnight arrival of the flood prevented residents from moving household goods to higher positions and, even when goods had been moved, they often had not been raised high enough. The flood came at a time of tension on university campuses as students protested the Vietnam War. Ohio National Guardsmen were on duty at Ohio University as a precaution against civil unrest, but instead they saw duty in the flood. The *Athens Messenger* reported that ‘it was strange to see the Guardsmen and students working together in the flood’ when only days before they had been antagonists.”(Schmidlin, p. 212.).

The NCDC Storm Database listed 22 flood events that were reported between 2014 and 2019. \$75,500 of property damage was estimated from these events. No deaths or injuries were associated with these events.

Map Modernization

FEMA's Flood Map Modernization initiative is a nationwide, \$1 billion effort to modernize the nation's inventory of flood maps. During this update the maps are produced in a seamless, countywide format. This process generated a digital flood layer that is compatible with most Geographic Information Systems (GIS) and Auto-CAD platforms. This digital layer allows local communities to utilize the digital floodplain data in conjunction with other data (such as parcel data) in order to enhance their local floodplain management programs.¹⁹

In 2007, FEMA began its process to modernize and update FIRM maps in Athens County. The following is a timeline of events that occurred during this process:

Initiated Map Modernization: 2007 Fiscal Year

Scoping Meeting: June 5, 2007

Preliminary Map Revisions: August 25, 2008

Open House: November 19, 2008

Comments and Appeal Period:

Start Date: December 11, 2008

Close Date: March 11, 2009

Letter of Final Determination: June 18, 2009

Maps Effective Date: December 18, 2007

2.2.7 Freezing Rain/Ice Storm

An ice storm occurs when precipitation occurs as rain but below-freezing temperatures on the ground cause the rain to freeze onto any objects with which it comes in contact. Ice storms and freezing rain are usually used synonymously. Ice storms create hazardous driving and walking conditions and can add significant weight to overhead utility cables and tree branches.

The average air temperature at ground level is 30 degrees during freezing rain but this phenomenon can occur at temperatures as low as 15 degrees. Freezing rain occurs in bands 25 to 100 miles wide, oriented west to east as a low pressure system and accompanying warm front approach from the south or southwest. Freezing rain only lasts an hour or two because the weather systems move through at thirty to fifty miles an hour. Prediction of ice storms is difficult because a slight temperature change at the ground surface can move the location of the ice storm more than 100 miles. Forecasting of the location and amount of ice accumulation is not precise.²⁰

Two ice storms in early 1994 created havoc in southeastern and southern Ohio as electric utility lines were damaged from the weight of ice and from tree limbs falling on them. Widespread power outages occurred. Falling tree limbs damaged automobiles and houses. According to the NCDC, forty people were injured and damages were estimated at \$10 million for these two events. The President's Day Storm of 2003 dropped up to two feet of snow in Athens County but counties

¹⁹ fema.gov

²⁰ Schmidlin, p.7.

south of Athens, where temperatures were warmer, had significant ice accumulation that knocked out electrical power for over one week in some situations.

The NCDC Storm Data from 2014-2019 showed 10 reports for winter storms or winter weather. Of these 10 reports, five included episodes of freezing rain. One death was indirectly attributed to a January 8, 2018 storm event when a semi-truck driver lost control of his vehicle on the US Route 33/50 bypass in the City of Athens.

All parts of Athens County can be affected by ice storms or freezing rain. Based upon the characteristics of this hazard, it is unlikely that all parts of Athens County will be affected at the same time or with the same intensity. The data available in the 2014-2019 NCDC report lists freezing rain multiple times and the historic record shows freezing rain frequently so this hazard is very likely to occur.

2.2.8 Hail

Hail forms in thunderstorm clouds as water drops are cooled to form ice pellets and additional water is frozen onto the small pellets in ever larger concentric circles. Strong updrafts allow the pellets to stay aloft for long periods and grow into hailstones. While all thunderstorms contain



hail, few thunderstorms produce hail that reaches the ground because it melts back to rain before reaching the earth.²¹

A thunderstorm can produce hail for several minutes leaving a “hailstreak” one-half mile or more wide and several miles long. A slow moving thunderstorm can produce hail for twenty minutes leaving hail to a depth of one foot. Any location in Ohio can expect hail on an average of two days per

Figure 2 Hail that fell near Amesville

year. Most hail is small and causes no damage except bruising of fruits and vegetables. Hail one inch or more in diameter can cause dents in cars and aluminum siding, break windows, tear awnings, strip leaves from trees, and destroy crops. Animals have been killed by large hail and persons have sustained injuries from large hail. Hail in Ohio has been recorded at up to three inches in diameter.²² According to the NCDC report, hail caused \$230,000 damage in Athens County in 2002 and a total of \$285,000 damage in the years 1982 to 2002.

²¹ Schmidlin, p. 303.

²² Schmidlin, pp. 303-304.

According to the National Climactic Data Center, between March 1, 2006 and December 31, 2012 there were 30 reported hail events in Athens County. No deaths or injuries were reported with these events. Between 2014 and 2019, the NCDC recorded a total of 12 hail reports on seven different days. The largest hail was measured at 2.5 inches. Property damage was listed at \$50,000 for the report with the 2.5 inch hail. There was an additional \$5,000 damage estimate with one other report for a total of \$55,000 estimated hail damage.

The SOHMP 2019 estimated annual hail loss in Athens County at \$71,910.62 or \$1.08 per capita. Hail and subsequent damage can occur anywhere in Athens County. Hail will likely occur every year, but events with large hail will be rarer. Even large hail is not uncommon. Therefore, this hazard is likely to occur.

2.2.9 High Wind

Besides tornadoes there are two types of damaging winds in Ohio, large-scale and downburst or straight-line winds. Large scale winds with speeds greater than fifty mph may occur behind a cold front associated with an intense low pressure system. Such winds may cover an extensive area and last for several hours. Downbursts are strong downdrafts, associated with thunderstorms. They can be as large as one mile wide and two to three miles long. The winds descend from a thunderstorm, strike the ground, and spread out in a fan shape.²³

According to Thunder in the Heartland, minor damage to property and vegetation begins with winds at speeds as low as forty five to fifty mph. Trees are uprooted or snapped off by winds at sixty to seventy mph. Additionally, shingles are blown from roofs, windows are broken, electric and telephone lines are blown down, and mobile homes may be pushed off foundations or overturned. At wind speeds greater than one hundred mph, large trees are uprooted or snapped off, moving cars are blown off roads, mobile homes are demolished, and roofs are blown from frame houses. Winds of more than one hundred fifty mph tear roofs and walls from well-built frame homes, toss cars through the air, and topple entire forests.²⁴

Athens County has had a number of high wind events according to the NCDC Storm Events Report. The report showed that a severe high wind event occurred on August 9, 2000 in which eight people were injured. The Athens Messenger, in an article titled *Storm collapses tent; 8 injured*, August 10, 2000 reported “a powerful thunderstorm caused the collapse of a tent covering the swine show ring at the Athens County Fairgrounds...At least eight people were treated by O’Bleness Memorial Hospital for personal injuries.” A storm in 2010 produced a tornado that touched down in one general location and the same storm also produced several regions where the damage was caused by straight–line winds. While both types of wind events can be very damaging, experts from the National Weather Service survey the damaged areas and can determine tornado impacts by the degree of rotation evident in the debris field. High winds can affect all areas and jurisdictions in the County. The NCDC Storm Database listed four reports of strong wind between 2014 and 2019. These listings are separate from reports of thunderstorms

²³ Schmidlin, p. 227.

²⁴ Schmidlin, p. 227.

or tornadoes which will be discussed in separate hazard profile sections. The four strong wind reports listed a total of \$85,000 of property damage. There were no deaths or injuries associated with these events.

High winds can happen anywhere in Athens County. Based upon historical records, this hazard is very likely to occur.

Downburst or Straight-line Wind: Downbursts are defined as strong winds produced by a downdraft over a horizontal area up to 6 miles (10 kilometers).

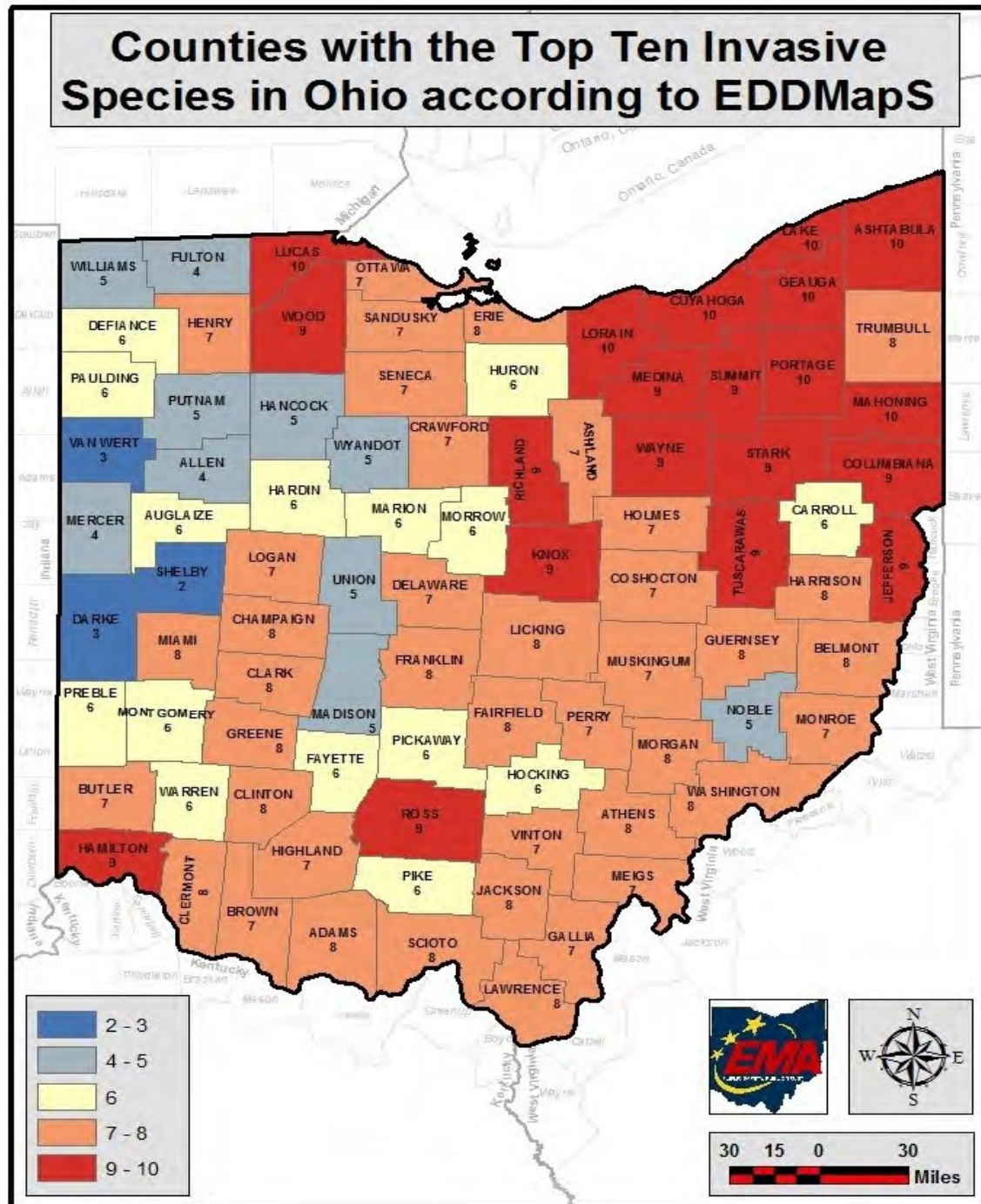
2.2.10 Invasive Species

Invasive species are added as a hazard because they are a growing threat to the ecosystems and economy in Athens County. The National Wildlife Federation defines invasive species as any living organism, whether amphibian, plant, insect, fish, fungus, bacteria, or even an organism's seeds or eggs, that is not native to an ecosystem and causes harm. These species can harm the environment, the economy, and even human health. In addition, species that can grow and reproduce quickly, spread aggressively, and have potential to cause harm are identified as "invasive".

The top ten invasive plant species in Ohio are:

- Bush Honeysuckles
- Autumn – Olive
- Buckthorns
- Common Reed Grass
- Garlic Mustard
- Japanese Honeysuckle
- Japanese Knotweed
- Multiflora Rose
- Purple Loosestrife
- Reed Canary Grass

Map 7 shows the number of "top ten" invasive species in Ohio by County. Athens County has eight of these.



Ed Brown, Agriculture and Natural Resources Educator with the OSU Extension Service says that environmental degradation is the main concern with invasives. They are also seeing an increase in Poison Hemlock and Wild Parsnip and are concerned that Giant Hogweed may become established in the County.

The Emerald Ash Borer moved through the state from northwestern Ohio to southeastern Ohio in just a decade and all the Ash Trees in Athens County have been killed. This poses a problem to landowners, the logging industry, and to those responsible for maintaining highway rights-of-way. An ODOT Planning Engineer with District 10 says the Ash Tree problem has been a topic of conversation at ODOT and with County Engineers for several years. District 10 had an \$800,000 contract in 2018 to remove dead trees on several roadways. While this helps, it is a small portion of the total number of dead trees in the state rights-of-way. District 10 also has a circular saw on an extending arm for tree removal. This is shared amongst all the counties in District 10 so its time in Athens County is limited. The dead Ash trees that have been standing dead for a while are too dangerous to remove by cutting at their base since the tops can vibrate loose and fall on the cutter. The engineer also noted that with narrow rights-of-way on county and township roadways, many of the dead trees will be outside of the right-of-way but could still fall into the road.

Invasive species can impact all areas of Athens County. Most state-listed terrestrial species already exist in Athens County so their likelihood of occurring in the future is 100%. While efforts are underway to minimize their spread, most of these efforts only slow the spread but do not eradicate it. It is likely that Athens County will continue to see the spread of invasive species.

Invasive Species: Any living organism, whether amphibian, plant, insect, fish, fungus, bacteria, or even an organism's seeds or eggs, that is not native to an ecosystem and causes harm.

2.2.11 Landslide/Rockfall

Landslide is the "...downward and outward movements of slopes due to rains or melting snow with accompanying damage and debris deposition."²⁵ As used in this section, landslide is the term that will describe all downslope movement of earth with the exception of rockfall which is the relative free-fall of rocks down a vertical or very steep slope. Downslope movement of earth has been grouped into several categories based on rate of movement and the type of geologic material associated with the movement. The types common to Athens County are rockfall, debris fall, slump, earthflow, and creep.²⁶

²⁵ Hazard Analysis and Risk Assessment, OEMA, p. 19.

²⁶ The Prediction of Unstable Slopes in Southeastern Ohio, John W. Sowers, August, 1975, P. 16.

There are many causes of slope movements, but they can be grouped into two general categories, geologic conditions and triggering actions. The geologic conditions are steep slopes, angle of rock



Figure 3 Landslide

layers, highly fractured rock, abundance of ferric oxide (red colors) in clay or clay shales, porous or permeable rock, soluble rock, water soluble cementing agents associated with certain rocks such as sandstone, presence of clay seams, clay soils, or clay shales subject to groundwater lubrication, and an influx of water from rain or drainage. The triggering actions are vibrations either natural or manmade, oversteepening of slopes, removal of lateral support at the toe of a slope, the collapse of drift mine workings, the weighting of the upper portion of a slope with fill or buildings, removal of vegetation from a slope, and water in excess that adds weight, dissolves rock, lubricates clay seams and increases pore water pressure in the soil.²⁷ Freezing and thawing also play a large role as triggering mechanisms.

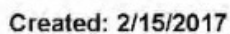
Records of landslide on state highways are kept by ODOT at the District level. District 10, which includes Athens County, lists 180 – 200 landslides per year compared with 15 for District 8 (southwestern Ohio), 12 for District 9 (southern Ohio), and 20 for District 11 (eastern). County, township, and municipal highway departments also spend considerable resources trying to prevent and having to repair landslides.

In addition to expenses for the maintenance and repair of streets and roads impacted by landslide, building foundations and utility lines are also affected. Buildings can be rendered useless and worthless if negatively impacted by landslide to a great enough extent. Landslides and rockfall can also be dangerous if they destroy a house that is occupied or destroy a roadway giving no advance warning to an unsuspecting motorist.

Landslide: The downward and outward movement of soil and rock material on slopes usually caused by moisture from rain or snow melt which acts as a lubricant.

²⁷ Ibid., pp. 21-22.

Total Geohazards:
Landslide Inventory



The hilly terrain and the underlying bedrock geology are significant contributors to the landslide incidence in southeastern Ohio. Map 8 shows the number of landslides recorded in Ohio, by

county, that are currently impacting the State's highway system and Athens is in the highest category with over 400 active areas. Athens County ranks third in the state with 831 landslides impacting state highways. A similar map was produced to show rockfall sites and Athens County was in the second highest rating category with between 201 and 400 sites.

The majority of funding to Athens County for past presidential disaster declarations has gone to repair roadways damaged by flooding or heavy rains. Many of the projects were landslide repairs and these tend to be the most expensive infrastructure projects, with the exception of bridge replacements, for county highway departments. Recent disaster assistance involved one federal declaration, Grant 4360 for February 14-25 flooding, and two state declarations, SDRP-0217 for February/March 2017 flooding and SDRPath18 for June 2018 flooding. For the federal declaration, \$1,903,163.57 was awarded to 11 jurisdictions in Athens County, primarily for roadway repairs. For the two state declarations, \$742,057.50 was awarded to three jurisdictions in Athens County, primarily for roadway repairs.

Landslide and rockfall are specific to those areas with the geologic conditions conducive to these hazards. Their occurrence in Athens County is widespread. It is certain that this hazard will continue in any given year, but large scale landslides and rockfalls will only occur in the wettest years. However, wet years are not uncommon, so this hazard should be considered very likely to occur.

2.2.12 Land Subsidence

Land subsidence is the settling of the earth's surface due to the loss of underground geologic support. In Athens County, this loss of support is associated with past underground coal mining activity. Old coal mines used the room and pillar mining technique whereby the majority of coal was removed creating large "rooms". Enough coal was left as "pillars" in an attempt to support the overburden or roof of the mine. Pillars were often removed at a later time or pillars that remained have deteriorated and lost strength. Wooden posts were also left as pillars and these too have deteriorated and failed. In these cases, or if the roof rock above the mine is weak and fractured, the weight of the rock and earth above the mine will collapse them into the mine and may impact the ground surface.

Land Subsidence: The settling of the earth's surface due to the loss of underground geologic support.

Land subsidence can destroy buildings, roads, and infrastructure. While Athens County has not had a subsidence that has destroyed a major highway or caused extensive damage to any buildings, the presence of abandoned underground mines is a threat to be recognized. Residents

of Athens County are required to purchase mine subsidence insurance at a cost of \$1 per year. Coverage is the lesser of \$50,000 or the actual cost of repairs to the home. The ODNR Division of Mineral Resources Management tracks subsidences and subsidence complaints. Some complaints of ground settling or foundation damage to homes are not actually caused by underground mines and this must be determined by the Division of Mineral Resources before a claim can be paid since only subsidence from abandoned mines is eligible for insurance reimbursement.

According to the Ohio Mine Subsidence Insurance Underwriting Association (OMSIUA), “mine subsidence is different from any other catastrophe that damages structures. A fire to a building is usually extinguished in minutes and repairs can be started shortly after settlement with the insurance company. A mine subsidence event causes ground movement and this process can last for several weeks, months, or years. Because of the ongoing movement, structures damaged by subsidence cannot be repaired until this movement ceases.”

The jurisdiction's Natural Hazards Risk Maps show the areas in Athens County that are susceptible to subsidence. The ODNR Division of Mineral Resource Management can provide information about subsidence's that have occurred in any given area of the state. The Division has also produced a booklet, Ask Before You Build, that serves as “a guide for landowners, developers and local officials to better assess abandoned mine lands before building.”

The OMSIUA files an annual report that lists subsidence claim payments made that year. In spite of 26 claims reported in Athens County, there were no claim payments made for the period 2007-2018. This means that individual policy holders who have structural problems with their homes are often mistaken about the causes. No claim payments will be made if the problem is not caused by an abandoned mine.

Subsidence is a hazard that is geographically defined based on the location of underground mines. It is isolated to those areas shown on the hazard maps. The lack of any claim payments made over an 11-year period indicates that this hazard does not occur frequently. When it does occur, it can have major impacts for the homes, businesses, or infrastructure affected. However, a subsidence area is usually small in scale. This event is unlikely and its impact isolated.

2.2.13 Thunderstorm and Lightning

Thunderstorms and lightning are mentioned as a separate category even though the subsections entitled High Wind and Flash Flooding cover some of the hazard issues. A thunderstorm often brings all three hazards; high winds, lightning, and intense rainfall. One key component to a thunderstorm is lightning, an atmospheric discharge of electricity. High speed videos (examined frame-by-frame) show that most lightning strikes are made up of multiple individual strokes. A typical strike is made of 3 to 4 strokes. The sudden increase in pressure and temperature from lightning produces rapid expansion of the air surrounding and within a bolt of lightning. In turn, this expansion of air produces a sonic shock wave which produces the sound of thunder. Lightning often seeks a path to the tallest object available. Trees, utility line/poles, tall buildings and even humans can be sought as a pathway for the discharging electricity.

Two deaths and one injury were caused by lightning in Athens County in the mid 1990's. Damages from lightning in 1995 and 2001 totaled \$81,000 in Athens County.

The NCDC Storms Database for 2014-2019 showed 26 reports for "Thunderstorm Wind". The highest reported wind speed was 74 MPH. \$144,000 was reported for property damage. No deaths or injuries were attributed to these events.

Thunderstorms and lightning can affect all areas and jurisdictions in the County. They occur frequently and will continue to occur with regularity.

2.2.14 Tornado

Athens County is located in the Wind Zone IV, and has a high risk of extreme winds rating. One tornado and varying levels of windstorms have been recorded in Athens County, all resulting in limited damages. Predicting what parts of Athens County have a greater chance of being struck by a tornado, however, is difficult. Tornadoes can strike with very little warning.



Figure 4: Tornado results 9/16/2010

Maps obtained from *FEMA's Taking Shelter from the Storm: Building a Saferoom in Your House* (<http://www.fema.gov/fima/tsfs13.shtm>) were used to determine the wind speed zone and tornado activity of Athens County. According to the map *Wind Zones in the United States*, Athens County is in the Zone IV (250 mph) wind zone. The map, *Tornado Activity in the United States*, shows that between 1 and 5 tornadoes were recorded per 1,000 square miles from Athens County. By

using FEMA's *Assessing Your Risk* chart, Athens County is calculated to be in the high level of risk from extreme winds.

A search done through Tornado Project Online at <http://www.tornadoproject.com> found one recorded tornado occurring between 1950 and 1995 in Athens County. The May 12, 1980 tornado had no recorded deaths or injuries. It measured F1 on the Fujita Tornado Measurement Scale. F1 tornadoes are classified as moderate tornadoes (73-112 mph winds) causing moderate damages.

The Historic Tornado Touchdown Map was produced using the ESRI/FEMA Project Impact Hazard Site. This map shows the May 12, 1980 tornado occurring in Athens County with a severity level of 1 on the Fujita scale. A tornado rated at level 5 on the Fujita scale hit Gallia County on April 23, 1968 according to the National Climatic Data Center. The National Climatic Data Center also indicated that six people have died from four southeastern Ohio tornado incidents dating from 1886.

A recent high wind/tornado event occurred on September 16, 2010. The County experienced a tornado event when severe weather and tornadoes swept across the state in the afternoon of September 16th. The National Weather Service confirmed 11 tornadoes in Wayne, Holmes, Fairfield, Athens, Perry, Meigs, Delaware and Tuscarawas Counties and in the Tarlton, Ohio area that borders 3 counties. The tornadoes ranged from EF-0 to EF-3. Athens, Meigs, Pickaway, Perry and Wayne Counties declared a local state of emergency. Thirteen people were injured in Athens County (OEMA). The following is a description of the storm event from a report prepared by NOAA:

A severe thunderstorm spawned a tornado touchdown along Kimberly Road, about 4 miles south-southwest of Nelsonville in Athens County, Ohio. The EF2 tornado traveled along Matheny Road/Route 269, passed through some woods, and then crossed Highway 691 before lifting; for a total of 3.3 miles. At its largest, the tornado was about 300 yards wide. The tornado obliterated several mobile homes along Matheny Road, while also snapping numerous large softwood trees at their trunks, and some hardwoods as well. It also lofted and set back down a hay bale of 1800 pounds in weight. Seven people were injured in York Township according to Athens County Emergency Management, and a total of 13 structures were destroyed. The damage indicated that the Nelsonville-area tornado lifted as the rear-flank downdraft of the rotating thunderstorm took over. The damage path from the 80 to 100 mph downburst stretched from about 3.5 miles west-northwest of The Plains, to 4 miles east of the center of Athens; a total of 10 miles. Athens County Emergency Management tallied 6 additional injuries within the downburst portion of the storm.

Winds were estimated to be near 100 mph as the downburst blasted through The Plains, OH in a path about a quarter mile wide. Greater than one million dollars damage occurred at Athens High School in The Plains, including its athletic scoreboard, visitors' stands, and a roof off the concession stand. Also, large air conditioning units were torn off of the school. Several more structures were heavily damaged or destroyed, including three unanchored trailers pushed or rolled near the High School parking lot. Many trees were uprooted and some snapped.

The downburst continued to the east southeast, while widening to almost a half mile wide. Winds were somewhat less overall in this final portion of the downburst, but still estimated in the range of 80 mph to 100 mph. Some damage occurred near Walmart and Lowes on East State Street, a few miles east of the center of Athens. However, an Auto Service Shop farther east endured very heavy damage (noaa.gov).

There was no loss of life during this tornado event that caused destruction in Athens County. The Ohio Emergency Management Agency damage assessment teams determined that 403 properties sustained damage during the storm.

- 30 properties destroyed - 2 insured, 28 uninsured

- 51 properties with major damage - 13 insured, 38 uninsured

- 83 properties with minor damage - 57 insured, 26 uninsured

- 239 properties that were affected - 103 insured, 136 uninsured

The levels of damage are defined as follows:

Affected

Single Family Residents - Some shingle damage, few broken windows, cosmetic damage to siding, and is repairable

Trailer - Minor dents to roof or siding

Minor Damage

Single Family Residents - One wall damaged, section of roof missing or damaged, and is repairable

Trailer - Utility connections broken and slight movement on piers or foundation

Major Damage

Single Family Residents - Substantial structural damage to walls, roof, etc, but repairable

Trailer - Wall and roof damage, shifted on piers or foundation

Destroyed

Single Family Residents - Total Loss, structure is compromised and not repairable

Trailer - Total Loss, bent Frame, buckled walls, roof (woub.org)

Tornado: A narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground.

While this hazard has proven extreme, incidents are still extremely rare and no deaths were recorded for Athens County from any tornado events. Due to the September 2010 tornado event the 2014 Plan increased the tornado hazard impact from 3 to 4. Since the 2014 Plan an additional tornado was noted in the NCDC Storm Database. On 10/28/2018 an EF0 tornado touched down in York Township in northwestern Athens County causing an estimated \$10,000 in property damage. There were no deaths or injuries from this event. The event narrative reads, “A very

weak tornado touched down near Nelsonville, along Cullison Road, where it lofted a trampoline into power lines and blew around some loose pieces of sheet metal. Additional damage occurred near the end of the path, along Kimberly Road. Here, several trees were uprooted or snapped, with one falling onto a house, penetrating the roof. The survey found all of the trees that fell were diseased or weakly rooted. Also, in this area, a metal carport was tossed into the woods. The estimated maximum wind speed was 55 mph. A video of the tornado was taken near Cullison Road, showing a rotating funnel above the ground, with the trampoline and sheet metal being picked up and thrown as it passed over.”

The tornado hazard can affect all areas and jurisdictions in the County. While its occurrence is rare, its impact can be severe. Climate change may be leading to a greater chance of tornado occurrence in Athens County. Data regarding this hazard will be closely watched for such changes, however, the risk rating for the tornado hazard will remain the same as for the 2014 Plan.

2.2.15 Wildfire

The peak seasons for wildfire in Southeastern Ohio are March, April and May, before vegetation “greens-up” and October and November, after leaf drop. These are the months when warm, windy, low humidity conditions are prevalent and vegetation is more susceptible to burning. Other factors that determine an area’s susceptibility to wildfire include topography and fuel. Slopes greater than 60 degrees have a high vulnerability to wildfire, slopes between 40 and 60 degrees are considered moderate and slopes less than 40 degrees have low wildfire susceptibility. Ground fuel is vegetation and woody debris that is found underneath the forest canopy. Ground fuel is also dried vegetation that can be found in unmowed or brushy fields. These are often former agricultural areas that are now reverting into early successional woody growth. Areas with a large amount of fuel are more at risk of damaging wildfire than areas relatively clean of undergrowth. Prolonged drought may cause an exceptionally long or active wildfire season, as well as contribute to extreme wildfire behavior or burning conditions. Multiple concurrent fires can tax resources and quickly create a lack of manpower and other resources and retard the ability to suppress fires rapidly and safely.

Wildfire: An uncontrolled fire that burns an area of combustible vegetation and typically occurs in rural areas.

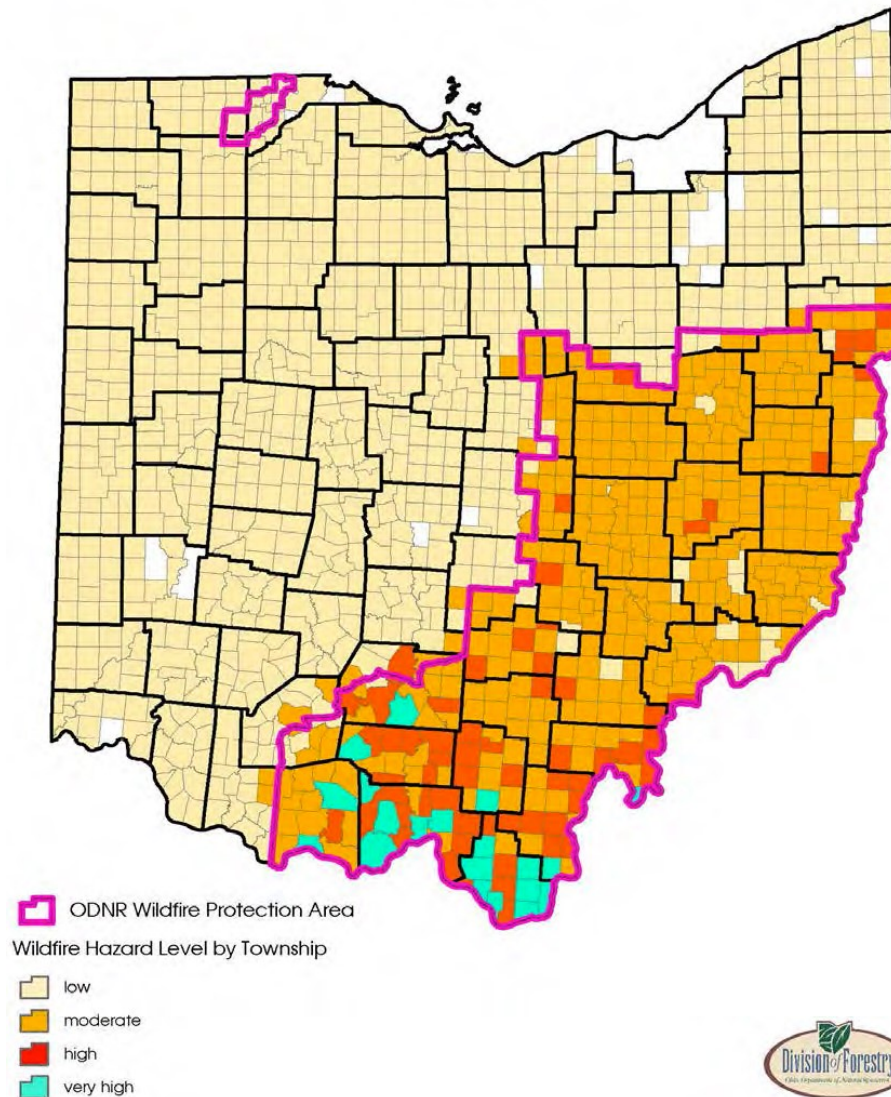
Map 9 indicates township wildfire hazard level statewide. Athens County has two townships, Waterloo and Troy, that are at high risk, and one that is low risk, Ames Township. The remaining townships are at moderate risk. The hazard map was produced by utilizing three main sets of data: historic wildfire occurrence and acres burned, fuel model land cover, and wildland urban

intermix/interface data. These datasets were chosen to represent a risk, the hazard, and the value of assets at risk.

Map 9 Ohio Wildfire Hazard Assessment

Ohio Wildfire Hazard Assessment

October 2012



Research on the occurrence of previous wildfire in Athens County was done and produced evidence that in 1999, Southeastern Ohio was plagued with forest fires. There were a reported 31 wildfires in Athens County which burned 112 acres. No significant structural damage occurred. In comparison, in year 2001 Athens County experienced 22 fires which burned only 49 acres. The SOHMP 2019 Draft shows a table titled Past Occurrences of Wildfire Events (1/1/07 to 12/31/17). During this eleven year period Athens County had the following:

- 84 total fire events
- 426 acres burned
- 5.07 acres/event and an estimated 8 events per year
- Fire size of 1 to 9.99 acres – 78 fires or 92.86% of all fires
- Fire size of 10 to 99.99 acres – 5 fires or 5.95% of all fires
- Fire size of 100+ acres – 1 or 1.19% of all fires

Based on the history of wildfire in Athens County the risk of a devastating wildfire event to occur appears to be relatively low. However, some conditions, namely steep and vegetated slopes that are associated with wildfire vulnerability, are found in Athens County. The County does not have a wildfire risk map.



2.2.16 Winter Storm/Blizzard

Winter storm and blizzard are combined into one hazard. Winter storms are typically associated with heavy snowfall and windy conditions. Blizzards are extreme winter storms that have snowfall, high winds, and extreme cold. The high winds in blizzard conditions create poor visibility and dangerous driving conditions even if snowfall is not heavy because dry snow can be blown around giving the effect of heavy snowfall. Some of the dangers associated with winter storms and blizzards are falling tree limbs, dangerous driving, utility outages, extreme cold, collapsed roofs, and severe wind chills.

There are several storm systems that can bring snow to southeastern Ohio. Those originating in the Canadian prairies are known as Alberta Clippers. Other places of origin are the Southern Plains, the Gulf of Mexico, and the Atlantic Coast. Very heavy snowfall can occur if moisture from the Gulf is drawn up into cold air sitting over Ohio. The heaviest snowfall occurs in a band less than one hundred miles wide so less than half of Ohio is usually affected by any single storm. Snowfall of six inches or more is considered a heavy snowfall in Ohio. This depth is expected once or twice a year in northern Ohio and only once every two or three years in extreme southern Ohio. Ohio's greatest snowfall amounts from a single storm have occurred in Ohio's eastern counties where storms moving along the Appalachian Mountains bring in moisture from the Atlantic Coast. Twenty to thirty inches of snow can fall during these events.²⁸

Athens County is on the edge of this area and can receive large quantities of snow if conditions are appropriate. The Thanksgiving snowstorm of 1950 is an example. Athens County received between twenty and twenty-five inches of snowfall during the storm.²⁹

The NCDC Storm Database listed two reports of Winter Storm, six reports of Heavy Snow, and eight reports of Winter Weather from 2014-2019. No property damage, no injuries, and one death (indirect-a traffic accident on an icy roadway) were attributed to these events.

Winter Storms and blizzards can affect all areas and jurisdictions in the County. The probability of winter storms is high since records indicate their regularity. However, blizzards are rare and not considered very likely.

Blizzard: An extreme winter storm that has snowfall, high winds, and extreme cold. The high winds in blizzard conditions create poor visibility and dangerous driving conditions.

²⁸ Schmidlin, p.6.

²⁹ "At Marietta, where weather records extend back to the early 1800's, the *Marietta Daily Times* reported the twenty-seven inches in this storm was the greatest in any known record here.....The press reported up to seventy persons were killed in Ohio by the storm, mostly from overexertion and heart attacks.", Schmidlin, pp. 39-40.

2.3 Risk Assessment by Jurisdiction

2.3.1 Background

The previous section covering hazard profiles was intended to provide an overview of the location and extent of historical hazard incidents. Based upon that information, risk can be determined, by analysis, of the potential impact of the hazard and the likelihood or probability that the hazard is going to occur. A major goal of this Update 2019 is to make the Plan fully multi-jurisdictional. That means providing each jurisdiction's unique hazard probabilities and potential impacts and customizing risk for that place. This determines the vulnerability of a place to any particular hazard and can lead to better mitigation planning.

In order to assess risk by jurisdiction, assets within that area need to be assessed and assumptions made about likelihood of personal injury or property damage should a hazard event occur. The assets to be reviewed include:

- Citizens and where they live
- Populations at greater risk due to age or lack of mobility
- Residential, commercial, and industrial buildings
- Critical facilities: Essential facilities, lifeline utility systems, transportation systems, high potential loss facilities, and hazardous materials facilities
- Repetitive loss properties
- New development

Risk was determined by multiplying a score for the probability of the hazard's occurrence by its possible impact. Each participating jurisdiction has its own unique hazard rating. This is a new addition to the Update 2019 and reflects increased awareness that each jurisdiction is unique and has its own set of risks that shape its mitigation action plan. The 2019 Plan Update discusses risk for each jurisdiction and included with each discussion is a corresponding hazard map, a table listing assets that are vulnerable to the hazards, and a risk assessment chart and table.³⁰ The charts are pie charts and the hazards list starts with dam failure which is shown in the 12 o'clock position on the charts. Hazards that don't exist in a jurisdiction are shown as "0" in the charts.

Asset: People, structures, facilities, and systems that have value to a community.

³⁰ A geographic information system was utilized to help assess vulnerability. The data used is from the Athens County Auditor's GIS program. The data can only be utilized for a general assessment of vulnerability since the structure and parcel assets are not attributed in detail. For instance, a structure can be a garage or a home or a business and the data does not tell us this. A developed parcel overlying a hazard zone such as a floodplain or an underground mine will be counted in the hazard zone even if a home or business on that parcel is not in the hazard zone.

The Athens County GIS data utilized for the risk analysis has several valuable statistics that require some caution for their use. The data includes appraised parcel value by land use classification. Parcels that are developed with structures can be separated from vacant parcels. This is valuable when trying to determine risk since there is not as much at risk from hazards on vacant land. However, GIS calculates that a parcel is in a hazard zone even when only a portion of the parcel is in the zone. The portion containing the improvement, a structure, may not be in the hazard zone but there is no way of knowing this. However, since we also have information about the numbers of structures in the hazard zone, we can get a per structure value for the jurisdiction and use this value to calculate total assets in the hazard zone based on the number of structures in the hazard zone. Another word of caution is that some structures in flood hazard zones may be mitigated and there is no way of knowing this since such attributes have not been added to the GIS database.

Vulnerability: Characteristics of community assets that make them susceptible to damage from a given hazard.

2.3.2 Scenarios and Assumed Impacts from Hazards

Vulnerability for hazards is geographically specific for those jurisdictions built in the mapped hazard zones: floodplains (including inundation areas below large dams), subsidence areas above mines, and landslide soil zones. The other hazards affect all jurisdictions on a fairly equal basis.

Damage estimates for hazards within jurisdictions will be based on previous incidents of each hazard. National Climatic Data Center historic records beginning in 1990 were analyzed for each hazard and Thunder in the Heartland³¹ provided historic Ohio weather extremes dating from the late 1800's. It is assumed that the largest jurisdiction, unincorporated Athens County will have higher damage estimates than smaller jurisdictions because of the differences in numbers of potentially affected assets. Athens City, with large numbers of high value assets will also have the greatest damage estimates. The following discussion of hazards attempts to establish some basis for determining losses when the hazard occurs.

2.3.2.1 Dam Failure

Inundation areas for dam failure have not been digitized into the County GIS. However, the state of Ohio and the U.S. Army Corps of Engineers have calculated loss scenarios and produced inundation mapping for many Class I dams. Dam failure will only affect areas below the dam and will be confined to drainage areas based on elevation. Failure of the Tom Jenkins Dam will have

31

the biggest impacts due to population centers located below the dam and the amount of water potentially released. The jurisdictions of Glouster, Trimble, Jacksonville, Chauncey, and Athens will all be impacted to varying extents. A failure of the Tom Jenkins dam could have impacts all the way to the Ohio River, 61 miles to the southeast. A failure when water elevations are at the Top of Active Storage Pool, which is approximately seven feet higher than the estimated elevation of the pool that would have been produced during the 1937 flooding, would produce \$136,630,300 in property damage and lead to the loss of 13-157 lives depending on timing of the emergency warning and whether the breach happens during the daytime or evening.

Loss calculations in those jurisdictions affected by a failure of the Tom Jenkins dam will be calculated on the following basis: losses in Glouster, Trimble, and Jacksonville will be calculated at 30% above the 1%-chance flood loss, losses in Chauncey will be calculated at 20% above the 1%-chance flood loss, losses in Athens City and unincorporated Athens County will be calculated at 10% above the 1%-chance flood loss. For loss calculations in the jurisdictions affected by dam failure but not in the Tom Jenkins Dam inundation area (only affecting unincorporated Athens County), an additional 10% of property loss will be added to the flood loss figure for that jurisdiction. This is based on a review of the Dow Lake inundation map that showed an additional 101 critical inundated structures (this figure includes residences) and 55 inundated structures from the probable maximum flood. Dam failure is more likely when there is already a flood underway and the dam is under stress. Many of these structures are on the edge of the floodplain and the damage above that of the 1%-chance flood will be minimal. Loss of life, due to rapid water rise, is possible.

2.3.2.2 Drought

In 2012 all 88 counties in Ohio received an agricultural disaster declaration from the Secretary of Agriculture due to the losses suffered from the 2012 drought. The Draft SOHMP 2019 shows agricultural production losses in Ohio from that year based on a comparison with production in 2011, a non-drought year. Vegetable and fruit production were harmed more than hay, bean, and corn production. Losses ranged from figures in the teens to as high as 50% for apples. Athens County agriculture is based more on corn, bean, and hay production than on fruits or vegetables. Athens County does not have extensive crop irrigation so if the drought becomes severe, there is no means of providing water to crops. It is reasonable to assume a 20% agriculture production loss in a drought year. Only the rural, unincorporated areas will be directly affected with agricultural production losses. However, the economic effects will be felt by everyone as the impact ripples through the economy.

The 2017 Census of Agriculture, County Summary Highlights, showed the market value of agricultural products (this includes livestock) sold in Athens County to be \$11,432,000. A 20% loss would amount to \$2,286,400. A severe drought that persists for multiple seasons or even several years would have considerably more impacts on agriculture.

Drinking water supplies can be the other major asset affected by drought. Athens County communities are fortunate to have ample public water supplies, all from buried aquifers. There

were no negative impacts on the water systems from the 2012 drought. The largest rural water district, Le-Ax, moved its treatment facility and invested in a well field after the drought of 1988. The system had previously used Lake Snowden as its water source and the drought, combined with other reasons of water quality, convinced them to obtain another source.

It is not anticipated that even a severe drought will have any serious repercussion on public drinking water supplies. Private supplies, depending on well depth or water body size, may be severely impacted. The 2010 census showed only 138 occupied housing units without complete plumbing facilities. Some of these units and others with complete plumbing facilities may not be connected to a public water supply. The total housing units in these circumstances are likely to be several hundred units countywide and are located in rural areas. Water hauling will be a requirement. It is not anticipated that drought will cause a loss of life.

2.3.2.3 Earthquake

For the previous Plan, Athens County NHMP 2014, a HAZUS scenario was completed for an Earthquake. Due to planning capacity constraints, the model was not run again for 2019. Mitigation actions will include HAZUS modeling for the 2024 Update. For purposes of NHMP 2019, damages within each jurisdiction will mirror the damage percentages utilized in the 2014 HAZUS model. The earthquake hazard affects all jurisdictions. Loss of life is a possibility with this hazard. Depending upon the earthquake hazard severity and soil moisture conditions at the time of the earthquake, ground shaking could create additional impacts from other hazards, specifically landslides and subsidence. These hazards are geography-specific and will affect assets in moderate and severe landslide areas and subsidence areas where underground mining occurred.

The 2014 HAZUS model estimated that about 4,077 buildings will be at least moderately damaged, which is over 16% of the total number of buildings in the County. An estimated 135 buildings would be damaged beyond repair. On the day of the earthquake the model estimates that only 70 hospital beds of the 135 beds (or 52%) would be available for use by patients already in the hospital and those injured by the earthquake. After one week, 66% of the beds would be back in service and by 30 days, 87% would be operational. HAZUS also estimates the amount of debris that will be generated by an earthquake, broken down to two categories: Brick/Wood and Reinforced Concrete/Steel. The model estimated that .120 million tons of debris would be generated with Brick/Wood comprising 58% of the total. This would be an estimated 4,600 truckloads to remove the debris. Further, the model notes shelter requirement needs. For this scenario, it is estimated that 302 households would be displaced and that 362 people will seek temporary shelter in public shelters. Building related losses are broken into two categories: direct building losses and business interruption losses. Total building losses for this scenario were 357.91 million dollars); 17% of the estimated losses were related to business interruption. The largest loss was sustained by the residential occupancies which made up over 63% of the total loss. In these scenarios, there were no losses computed by HAZUS for business interruption due to transportation and utility lifeline outages. Adjusted for an inflation rate of 2% per year or approximately 10% over the 5 year period since the last Plan update, total building losses for that HAZUS 2014 run would have been \$618.3 million or 14.4% of the appraised, improved parcel

value in the County. To calculate property losses for individual jurisdictions, it is assumed that 14.4% of the improved parcel values will be damaged in an earthquake. Injury and loss of life are possible.

2.3.2.4 Extreme Cold

This hazard will affect all jurisdictions, although the coldest temperatures have occurred at the lowest elevations in drainage “hollows” with minimal air circulation. Extreme cold will cause relatively minor building damage in the form of frozen and burst water lines. Extended extreme cold periods can cause building foundations to shift from frost heaving. Extended extreme cold periods can also lead to public infrastructure issues with damage to highway bases and frost heaving and landslides where public waterlines are located.

Rarely will someone die as a result of extreme cold but there are occasional reports of someone freezing to death due to heating systems that have stopped working or someone being asphyxiated due to heating systems that are malfunctioning and releasing toxic gases into a residence. Elderly populations are the most at risk. Property damage for two previous events in January 2014 listed \$50,000 and \$100,000 in damages across the County. Damage amounts will be smaller in less populated jurisdictions but this hazard can create sizable damage estimates. Damages will be estimated in \$10,000 increments per 10,000 population.

2.3.2.5 Extreme Heat

This hazard will affect all jurisdictions. Asset damage will be confined to agriculture, transportation systems where highways or railroad rails react negatively to the heat, overtaxed electric grids since the peak loads on power plants now come in warm weather from air conditioning use, and people who suffer from various heat-related illnesses. Elderly populations are the most at risk. Heat related illness and loss of life are possible. Property damage will be minimal based on previous extreme heat events.

2.3.2.6 Flooding (Flash)

Flash flooding will affect jurisdictions with smaller drainage systems that react quickly to storm events. Many areas prone to flash flooding are not mapped as floodplains in Athens County. This is primarily because funding to perform such mapping is not available or is difficult to obtain. Almost any area can experience flash flooding if a rain event is hard enough. Water in flash flood areas tends to have higher velocities due to the drainages being headwaters or higher in elevation and therefore steeper. Loss of life is possible due to the rapid rise in water elevation. Higher velocities can float and carry objects not fastened down, particularly vehicles, sheds, boats, and mobile homes. These can then become floating hazards that crash into fixed structures. Flash floods can create erosion problems also because of flow velocity. This can undermine highway systems and buildings.

Flash floods will not have the same impacts as large riverine floods that cover more land and persist for longer periods of time. Injury and loss of life are possible. Damages from flash flooding will be estimated in \$25,000 increments per 10,000 population.

2.3.2.7 Flooding (Riverine)

Riverine flooding has caused the most damage of any natural disaster in Athens County. Of 12 instances where federal funds were made available to Athens County since 1964, 10 of those instances were for flooding. This hazard affects those jurisdictions with floodplains. Asset damage is calculated with some of the same assumptions that were used in NHMP 2014, but with more refined GIS figures from the County and on a jurisdictional basis. The assumptions are:

- Asset values are a combination of residential, commercial, industrial, tax exempt, utility, and railroad improved properties.
- Vacant properties are not included in the total asset value that is subject to damage by a hazard.
- Assets in geographic hazard zones (floodplain, landslide, and subsidence) have their parcel values adjusted downward by a factor that is the percentage of structures in the hazard zone divided by the percentage of parcel value in the hazard zone. This will eliminate parcels that show up in a hazard zone without corresponding structures also in the hazard zone.
- Total contents value is estimated at 50% of appraised parcel value.

Damage from flooding is 20% of real estate structure value and 63% of mobile home value. Damage from flooding is 20% of contents value for real estate and 90% of contents value for mobile homes. Injury and loss of life are possible.

2.3.2.8 Freezing Rain/Ice Storm

Freezing Rain/Ice Storm impacts people by making walking and driving hazardous. Freezing rain also builds ice on tree branches, utility lines, and other overhead structures making them prone to breakage or falling over. The majority of property damage is caused by trees toppling onto homes and other structures, including power lines. Automobiles are also damaged in this way. Injuries and deaths are caused by highway accidents on slippery roadway surfaces and by trees falling on people. Weather forecasting for this hazard is improving but it is still difficult to predict just where temperature and precipitation conditions will be right to produce a freezing rain event. This event can happen in all jurisdictions. Damage in any jurisdiction is expected to be between \$10,000 and \$50,000 based on previous instances. Damages will be estimated in \$10,000 increments per 10,000 population. Injury and loss of life are possible.

2.3.2.9 Hail

Hail can be very destructive to roofing, automobiles, tents, crops, and other objects made of sheet metal, fabric, or lightweight materials. Injury and death are possible, although unlikely. A reported hail event in Nelsonville showed a damage estimate of \$200,000. Several other hail events indicated losses in the range of \$1000-\$50,000. This hazard will affect all jurisdictions. Damages will be estimated in \$10,000 increments per 10,000 population.

2.3.2.10 High Winds

These are winds separate from tornadoes and strong thunderstorms. These winds often arrive when strong cold fronts move into the area. While generally not as damaging as tornadoes and

thunderstorms winds, they can cause serious damage to property and injury or death if trees are blown down. Unique incidents can also occur such as in 2001 when a newly constructed and unsupported block wall for a new, large retail store was toppled by high winds. Damage for that incident was listed by the NCDC at \$65,000. Several regional reports showed property damage in the range of \$50,000-\$75,000. A high wind incident at the Athens County Fair also collapsed a large tent and injured 8 people, none life-threatening. High winds can happen in any jurisdiction. Injury and death are possible since large trees and other objects can be blown on top of people. Damages will be estimated in \$25,000 increments per 10,000 population.

2.3.2.11 Invasive Species

It is very difficult to quantify damage amounts for invasive species and no attempt will be given in this NHMP Update 2019. Invasive species have their biggest impact disrupting native ecological processes by crowding out native species or occupying environmental niches where there is no predation on the invasive. This is the case of the Emerald Ash Borer that has now decimated most of the native Ash Tree population in Ohio.

The biggest financial impact to citizens is the reduction in agriculture. While difficult to quantify, effects can be felt from lower yields or the increased cost of having to apply pesticides or herbicides to deal with the problem. With the case of invasive plants that inhabit the county's ample woodlands, there is reduced yield of timber or the complete devastation of a species such as Ash. Native species that help provide diversity in the forest are also outcompeted and the ecosystem is left in a situation where there are fewer species.

Invasive species can pose a threat to life when trees are killed and are more prone to fall over in high winds. Highway Departments have to spend more money removing these trees from the right-of-way and cannot keep up with all the trees that have died recently.

2.3.2.12 Landslide/Rockfall

This is a geography-specific hazard based primarily on soil type. Landslide and rockfall are exacerbated by the presence of water which acts as a lubricant and can also become a mechanical agent when it freezes and thaws and creates movement in soils and breaks rock off of steep rock faces. Floodwaters can also create unstable situations in the soils when the bottoms of slopes are eroded away. Support is reduced below and gravity starts mass movements of rock and soils.

The majority of funding in flood disaster declarations in Athens County goes to repair of roads and bridges, in large part due to landslides adjacent to creeks and rivers. The last federal disaster declaration that included Athens County, DR-4360, awarded \$1,242,898.41 of federal funds and \$197,955.39 of state funds to just the Athens County Engineer for repairs to the County highway system. From the same declaration, the City of Athens received \$255,881.54 in federal funds and \$23,867.70 in state funds for a variety of issues, but \$74,391.90 went to repair just one moderately sized landslide. The Village of Glouster received \$29,981.33 in state funds to repair a landslide adjacent to Sunday Creek after flooding in 2018.

Based upon the history of landslide in the County, repairs for landslides can range from as low as several thousand dollars, if the roadway is just leveled back to original grade and minor stabilization is provided with rock placement, to as high as several hundred thousand dollars for a large-scale stabilization. A large flood event will usually create multiple landslides so the loss estimates for a large jurisdiction like the County can go over \$1,000,000. An earthquake that happens at a time when soil moisture is high could be quite devastating with damages easily into multiple millions of dollars.

Buildings constructed in landslide areas are subject to foundation problems from the movement of soils. The heavy clays are also prone to high shrink/swell with water present. The HAZUS earthquake scenario that was run for the NHMP Update 2014 indicated 4,706 buildings would be moderately damaged with repairs running to \$357,910,000. If soil moisture conditions are appropriate, this number may even be low because landslides will be triggered.

Most homes will not likely suffer damage during a wet period causing landslides. However, some homes may suffer serious foundation damage. For damage estimate calculations, figures of \$500 per structure in moderate landslide zones and \$1,000 per structure in severe landslide zones will be utilized. There are no calculations for highway damage but \$1,000,000 will be used as an estimate since numbers this large can occur on just the county highway system. Injury and loss of life are possible but unlikely.

2.3.2.13 Land Subsidence (Mines)

This hazard is also geography-specific to those portions of the County where underground mining for coal took place. Everyone who owns property in Athens County pays \$1/year into an insurance pool that is available for owners who experience subsidence problems from an older, abandoned mine. Between 2007-2018, there were no subsidence-related claims paid out. As with the landslide hazard, should an earthquake occur, subsidence could be triggered since the stability of the bedrock over a mine and the stability of remaining coal piers in the mine are threatened. The hazard maps indicate jurisdictions most at risk from subsidence, however, based on historic claims information, damage in any year will likely not be more than \$50,000 and this would be a worst-case scenario of subsidence being triggered by an earthquake. Injury and loss of life are possible but unlikely.

2.3.2.14 Thunderstorm/Lightning

Thunderstorms are a common occurrence in Athens County. Their intensity can create devastating winds, high rainfall amounts, and lightning. Thunderstorms can happen in any jurisdiction and damages can be extreme. The NCDC list of damages from thunderstorm winds is extensive and shows property damage of \$500,000 on 4/15/93, damage of \$500,000 on 11/11/93, damage of \$200,000 on 6/4/02, damage of \$150,000 on 6/29/2012 and ten instances ranging between \$10,000 and \$50,000.

Lightning strikes can also injure and kill residents either by direct hits, by causing tree limbs to fall, and by causing fires to objects hit by the lightning. On 4/11/01 lightning caused \$40,000 of property damage in Stewart. Two incidents in June, 1995 created \$20,000 of damage in each. There was one lightning report in the NCDC storm database covering 2014-2019 and \$4,000 was

reported for property damage. Damages will be estimated in \$10,000 increments per 10,000 population.

2.3.2.15 Tornado

A tornado can be one of nature's most devastating forces, destroying everything in its path. Tornadoes can strike any jurisdiction and Athens County has witnessed several. The NCDC storm database showed an F1 tornado on 5/12/80 causing \$250,000 in damages and an EF2 tornado on 9/16/10 causing \$750,000 in damages. An EF0 tornado on 10/18/18 caused an estimated \$10,000 in damages. Depending on where a tornado strikes and its intensity, damages can vary widely. Millions of dollars in losses are possible and injury and death are possible.

The EF2 tornado that struck on 9/16/10 hit a rural location that did have a number of homes on smaller parcels along the roadway. If this tornado touched down in a more densely settled area the damages would have been higher. Damages are estimated based on a scenario of an EF2 tornado touching down over an area 100 yards wide by one mile long and causing real property losses of 50% and contents losses equal to 50% of the real property loss. The 36 acre damage area will be figured as a percentage of the total area of the jurisdiction and 50% of that percentage will be multiplied by the developed parcel value to determine real property loss and half of that will be contents loss.

2.3.2.16 Wildfire

Drought years are when wildfire is most likely to occur. Records of past fire seasons in Athens County showed no structural property damage, no injuries, and no loss of life. During one 11-year period of record, the average size wildfire in Athens County was 5 acres with an average of five such fires per year. There was only one large fire of approximately 100 acres.

Wildfire in Athens County is usually associated with rural areas where a trash burning fire gets out of control. Urban jurisdictions are not likely to be at much risk because there is no vegetative undergrowth to burn. While wildfire can affect all jurisdictions, it is most likely to occur in the unincorporated portion of Athens County. Injury and loss of life are possible but unlikely.

2.3.2.17 Winter Storms/Blizzard

Winter storms occur frequently in Athens County. Blizzards are more extreme events and do not occur very often. The NCDC records show a winter storm caused \$80,000 of damage on 1/20/12. Historically, 1977 and 1978 brought two of Ohio's worst years for blizzards. Statewide, there was an estimated death toll of 51 from the January 1978 blizzard. Most property damage occurs when heavy wet snows fall and roofs collapse or trees are weighted down and topple onto buildings. Blizzards can bring high winds that can tear off roofs and also blow trees down onto buildings and power and communication lines. The elderly population is particularly susceptible to this hazard, particularly if the event is prolonged. Regional damage costs from a heavy snow/blizzard scenario in January 1995 were listed at \$500,000. The County could see damages in the hundreds of thousands of dollars and injury and death are possible. Damages will be estimated in \$25,000 increments per 10,000 population.

2.3.3 Albany Village

Key Facts

- Albany only has 8.8 % of its land area in landslide hazard zones.
- Albany does not have any flood or subsidence zones.
- Albany does not have any repetitive loss properties.
- Albany is adjacent to the Ohio University airport.

Assets

The Village of Albany is fortunate to have been sited outside of flood zones and in an area that was never underground mined for coal. This is unique amongst the jurisdictions in Athens County. The Village of Albany has 965 structures and a developed parcel value of \$29,997,290.

Critical Facilities

- Wastewater treatment plant
- Volunteer fire department
- EMS station
- Medical clinic
- US 50/32 bridge
- Railroad bridge
- Lee Township building and yard
- Water Tower

Vulnerabilities

The Village of Albany has an elderly population of 154 aged 65+ and an institutional population of 23.

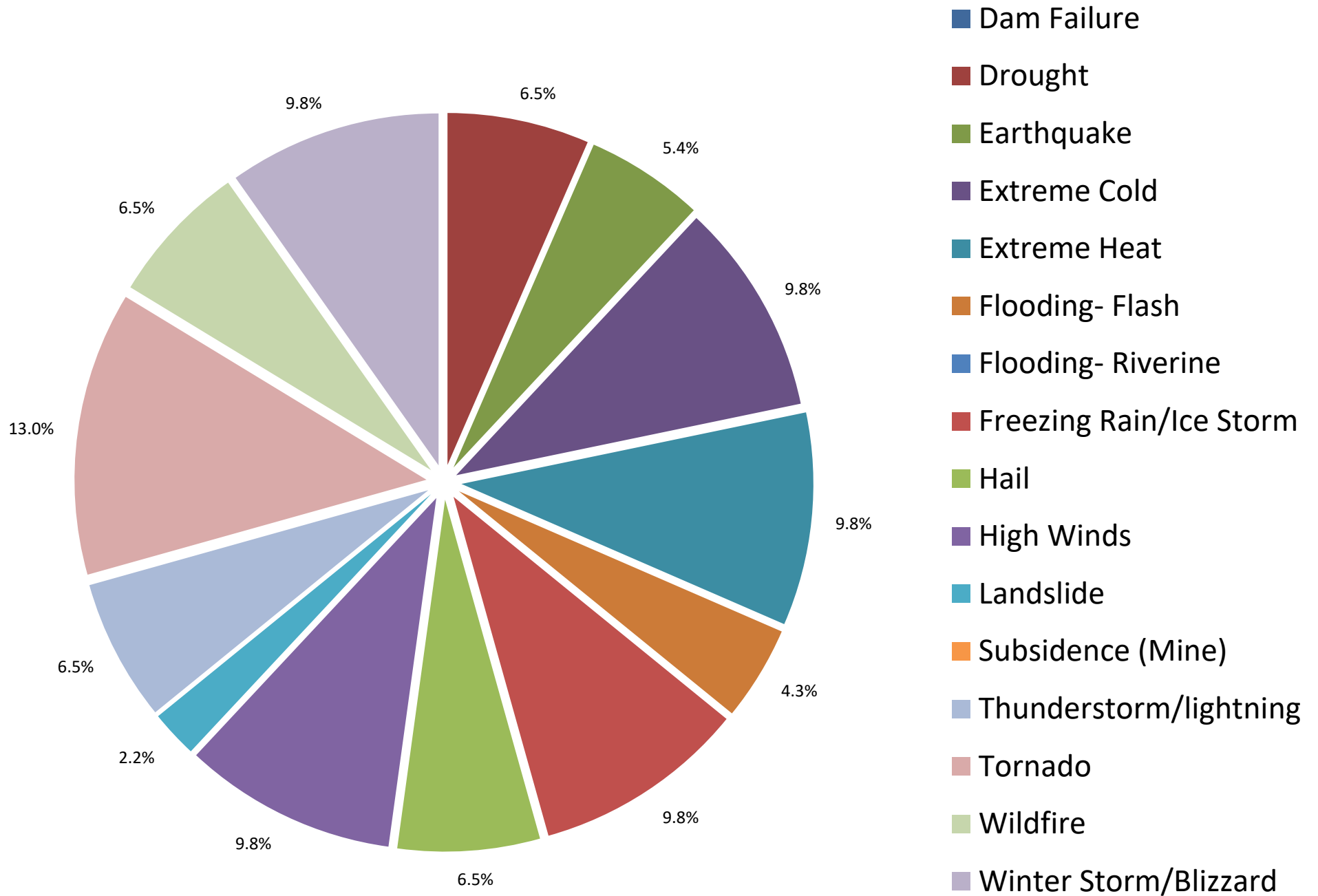
Hazard	Potential Damages	Injury/Death
Dam Failure	No hazard	None
Drought	Minor <\$10,000	Unlikely
Earthquake	\$1,992,217	Likely
Extreme Cold	\$10,000	Possible
Extreme Heat	Minor <\$10,000	Likely
Flooding (Flash)	\$25,000	Unlikely
Flooding (Riverine)	None	None
Freezing Rain/Ice Storm	\$10,000	Possible
Hail	\$10,000	Unlikely
High Winds	\$25,000	Possible
Invasive Species	Minor	None
Landslide/Rockfall	\$6,000	Unlikely
Land Subsidence (mines)	None	None
Thunderstorms/Lightning	\$10,000	Possible
Tornado	\$1,974,468	Likely
Wildfire	Minor	Unlikely
Winter Storms/Blizzard	\$25,000	Possible

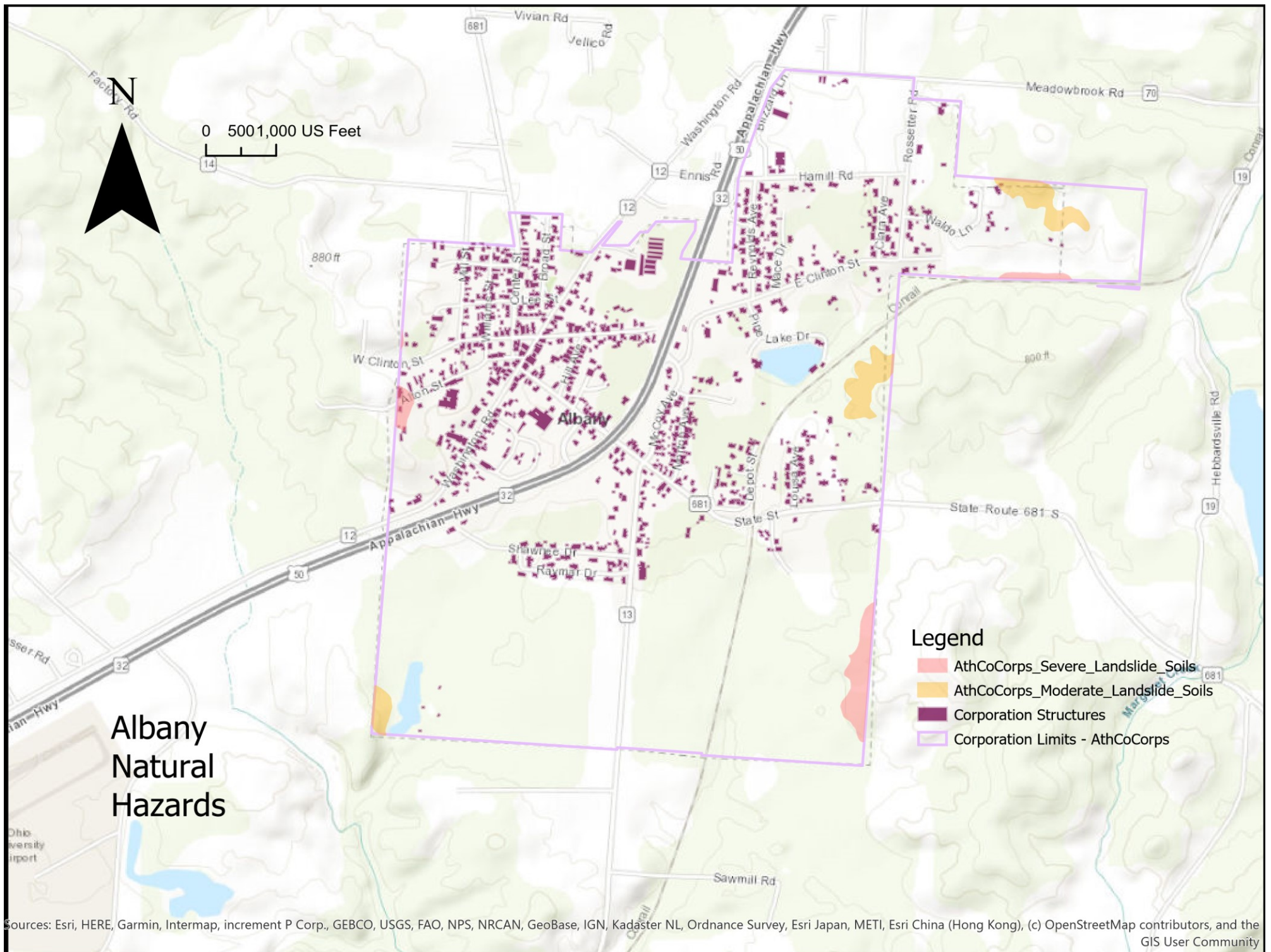
New Development

There is no new development in the Village of Albany.

ALBANY									
Asset	Total	# in Floodplain	% in Floodplain	# in Landslide/Moderate	% in Landslide/Moderate	# in Landslide/Severe	% in Landslide/Severe	# in Subsidence	% in Subsidence
Land (acres)	820.4	0	0	52.4	6.4%	19.3	2.4%	0	0%
Population ¹	901							0	
Residential Parcels	319	0	0	1	0.3%	3	0.9%	0	0%
Commercial Parcels ²	47	0	0	0	0.0%	1	2.1%	0	0%
Industrial Parcels	0								
600-880	76					1	1.3%		
Structures ³	965	0	0	2	0.2%	13	1.3%	0	0%
Developed Parcel Value	\$29,997,290	\$ -	\$ -	\$ -	0.0%	\$ 716,620	2.4%	\$ -	0%
Institutional Population ⁴	23								
Elderly 65+ ⁴	154		Tornado	\$1,316,312			NOTES		
Repetitive Loss Properties	0		Tornado Contents	\$658,156			1. 2018 estimate		
Critical Facilities	7		Total Tornado	\$1,974,468			2. includes apartments with 4+ rental units		
							3. County LIDAR		
			Earthquake	\$4,319,610			4. 2010 census		

Albany Natural Hazards Relative Risk





2.3.4 Amesville Village

Key Facts

- Amesville has 32.3% of its land in the floodplain but only 3 structures (1.8% of all structures) in the floodplain because of a mitigation project after flooding in 1998.
- Amesville should have its flood maps updated because there is concern that the existing FEMA flood maps do not accurately depict the 1%-chance flood. Two floods, one in 1997 and one in 1998, far exceeded the 1%-chance flood levels.
- Amesville sits at the confluence of 3 drainages and can be subject to both flash flooding and riverine flooding.
- Amesville has only 2 structures in a landslide area (moderate).

Assets

The Village of Amesville has 169 structures and a developed parcel value of \$8,547,580.

Critical Facilities

- Wastewater treatment system
- Water treatment systems
- Ames VFD
- Ames Township building and yard
- Amesville Elementary School
- SR 550 bridge

Vulnerabilities

The Village of Amesville has 22 residents 65+ years in age and 5 repetitive loss properties.

The FEMA flood map for the Village may not accurately show the 1%-chance flood area.

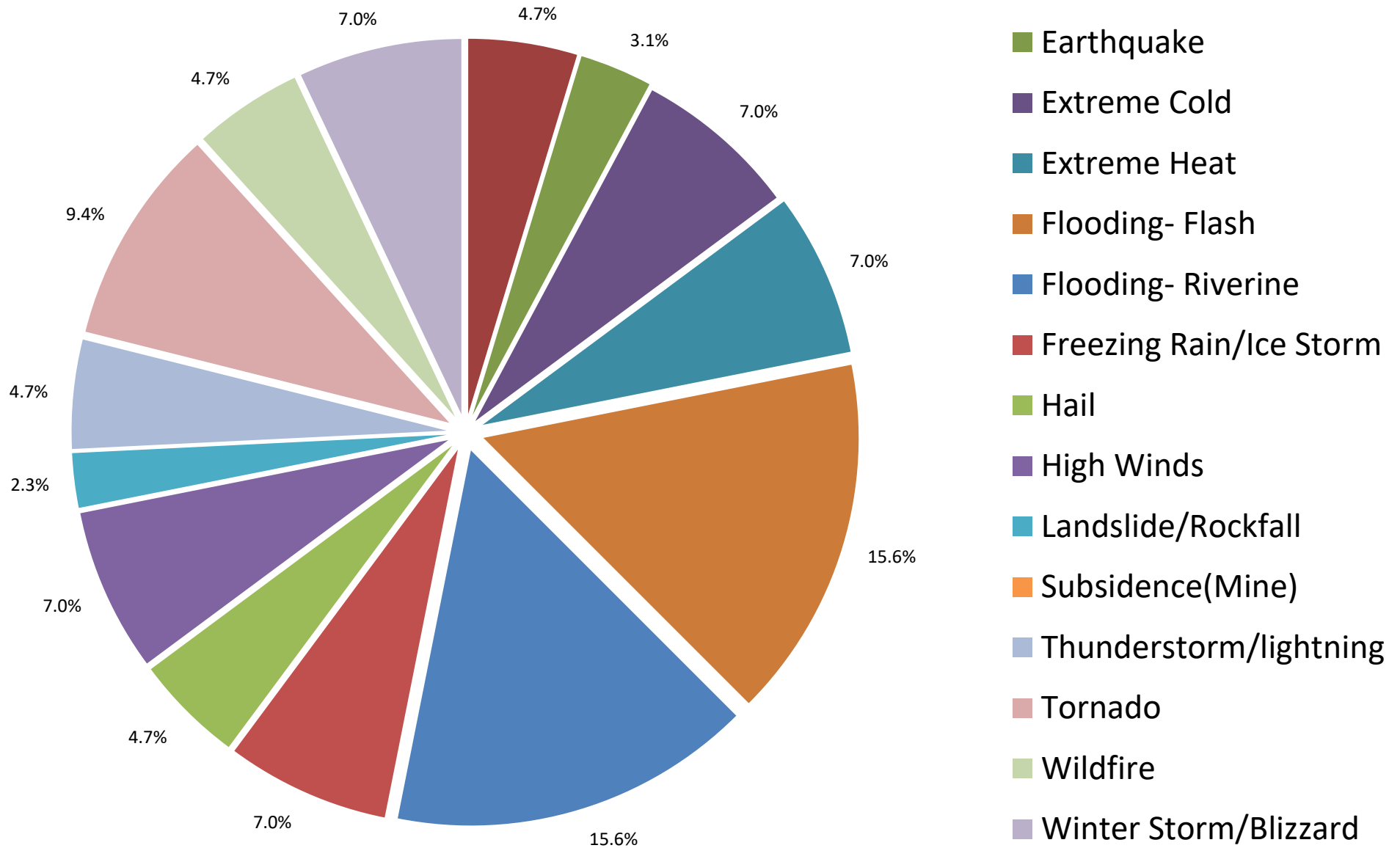
New Development

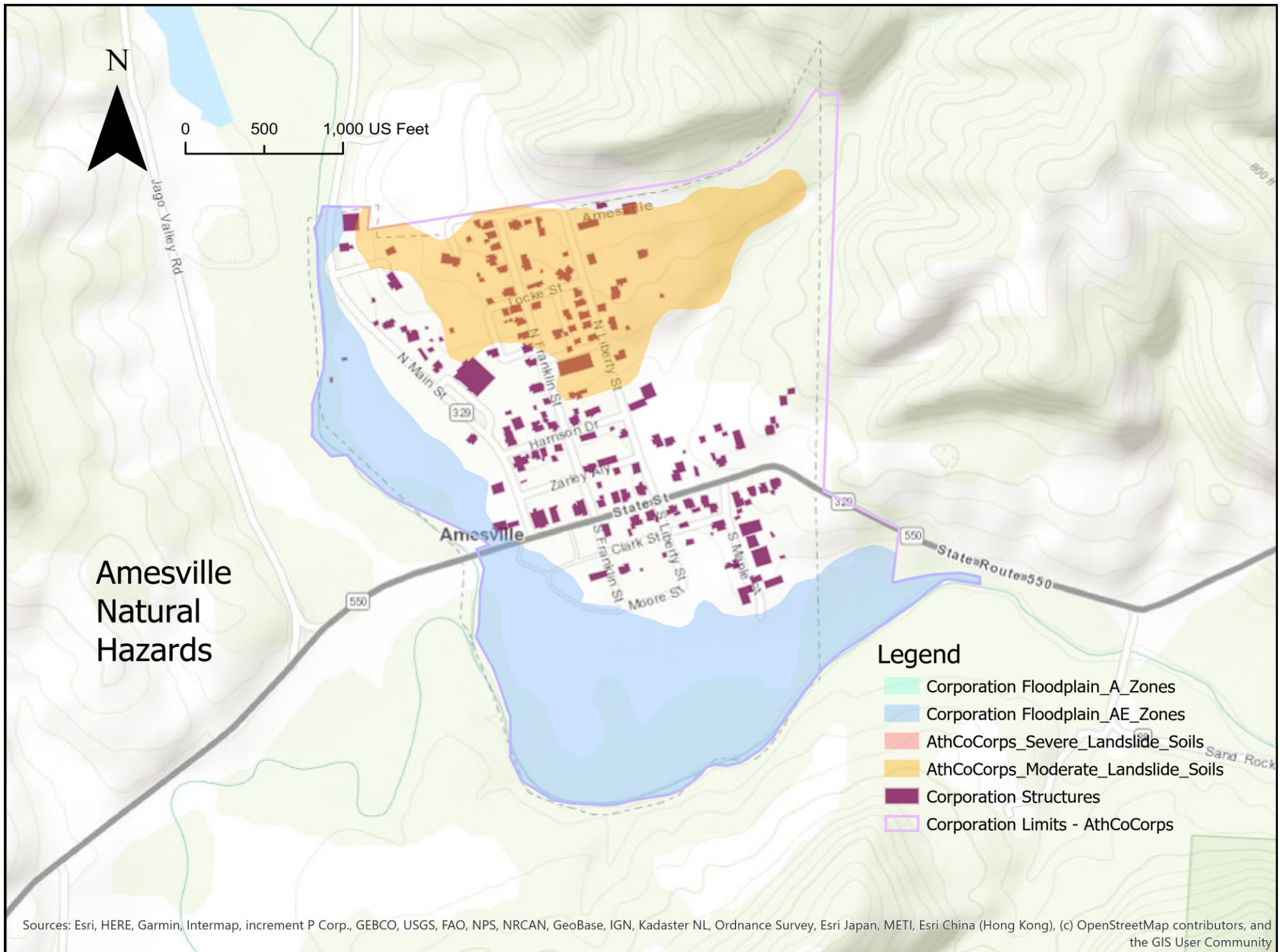
Amesville had a wastewater treatment system constructed about ten years ago.

Hazard	Potential Damages	Injury/Death
Dam Failure	No hazard	None
Drought	Minor <\$10,000	Unlikely
Earthquake	\$1,230,852	Likely
Extreme Cold	\$10,000	Possible
Extreme Heat	Minor <\$10,000	Likely
Flooding (Flash)	\$25,000	Unlikely
Flooding (Riverine)	\$39,164	Possible
Freezing Rain/Ice Storm	\$10,000	Possible
Hail	\$10,000	Unlikely
High Winds	\$25,000	Possible
Invasive Species	Minor	None
Landslide/Rockfall	\$1,000	Unlikely
Land Subsidence (mines)	None	None
Thunderstorms/Lightning	\$10,000	Possible
Tornado	\$3,150,644	Likely
Wildfire	Minor	Unlikely
Winter Storms/Blizzard	\$25,000	Possible

AMESVILLE									
Asset	Total	# in Floodplain	% in Floodplain	# in Landslide/Moderate	% in Landslide/Moderate	# in Landslide/Severe	% in Landslide/Severe	# in Subsidence	% in Subsidence
Land (acres)	146.5	47.3	32.3%	28	19.1%	14.8	10.1%	0	0%
Population¹	157								
Residential Parcels	86	4	4.7%		0.0%		0.0%		0%
Commercial Parcels²	10	3	30.0%		0.0%		0.0%		0%
Industrial Parcels	0								
600-880	130	28	21.5%	0	0.0%	0	0.0%	0	0%
Structures³	169	3	1.8%	2	1.2%				
Developed Parcel Value	\$8,547,580	\$618,580	7.2%	\$1,916,810	22.4%	\$ -	0.0%	\$ -	0%
Institutional Population⁴	0								
Elderly 65+⁴	22		Tornado	\$2,100,429			NOTES		
Repetitive Loss Properties	5		Tornado Contents	\$1,050,215			1. 2018 estimate		
Critical Facilities	5		Total Tornado	\$3,150,644			2. includes apartments with 4+ rental units		
							3. County LIDAR		
			Earthquake	\$1,230,852			4. 2010 census		

Amesville Natural Hazards Relative Risk





2.3.5 Athens City

Key Facts

- Home to Ohio University with a population of approximately 20,000 students, most of whom live within the City limits.
- Athens City has 7,937 residents living in non-institutionalized group quarters (primarily students in dormitories)
- The City has not experienced a 1%-chance flood since the channelization project was constructed. The channel is not designed to convey a 1%-chance flood event.
- 23% of the City's structures are in the floodplain.
- 39% of the City's structures are in severe landslide areas.
- Athens City has no repetitive loss properties.

Assets

The City of Athens is the county seat and key center of activity in Athens County and the region. The City has 5,779 structures and a developed parcel value of \$2,426,411,340. Additionally, The Community Center located on East State Street in Athens serves as an emergency shelter and heating or cooling station when needed.

Critical Facilities

- ODOT facility
- W. Union St. bridge
- Richland Ave. bridge
- Old Richland Ave. bridge
- Stimson Ave. bridge
- Ohio Highway Patrol
- Athens P.D.
- Athens Co. Sheriff/EOC
- O.U. campus security
- Fire stations 1 and 2
- EMS
- Southeastern Psychiatric Hospital
- O'Bleness Hospital
- City-County Health Dept.
- Holzer Clinic
- Frontier Communications

Hazard	Potential \$ Damages	Injury/Death
Dam Failure	\$148,975,526	None
Drought	Minor <\$10,000	Unlikely
Earthquake	\$349,403,233	Likely
Extreme Cold	\$30,000	Possible
Extreme Heat	Minor <\$10,000	Likely
Flooding (Flash)	Minor < \$25,000	Unlikely
Flooding (Riverine)	\$135,432,297	None
Freezing Rain/Ice Storm	\$30,000	Possible
Hail	\$30,000	Unlikely
High Winds	\$75,000	Possible
Invasive Species	Minor	None
Landslide/Rockfall	\$1,288,500	Unlikely
Land Subsidence (mines)	None	None
Thunderstorms/Lightning	\$30,000	Possible
Tornado	\$21,631,839	Likely
Wildfire	Minor	Unlikely
Winter Storms/Blizzard	\$75,000	Possible

- AEP substation on The Ridges
- Kimes reservoir
- Longview water tower
- Curtis St. pumping station
- Ridges water tower
- O.U. physical plant
- AEP substation on Curran Dr.
- Frontier switching station – downtown
- AEP substation – campus
- City wellfield
- Currier St. and Kimes Nursing home pumping station
- Highland reservoir
- Athens WWTP
- Athens WTP
- Columbus Rd. water pumping station
- Microwave Communication System throughout the city
- Richland Avenue and Depot Street Lift Stations

Vulnerabilities

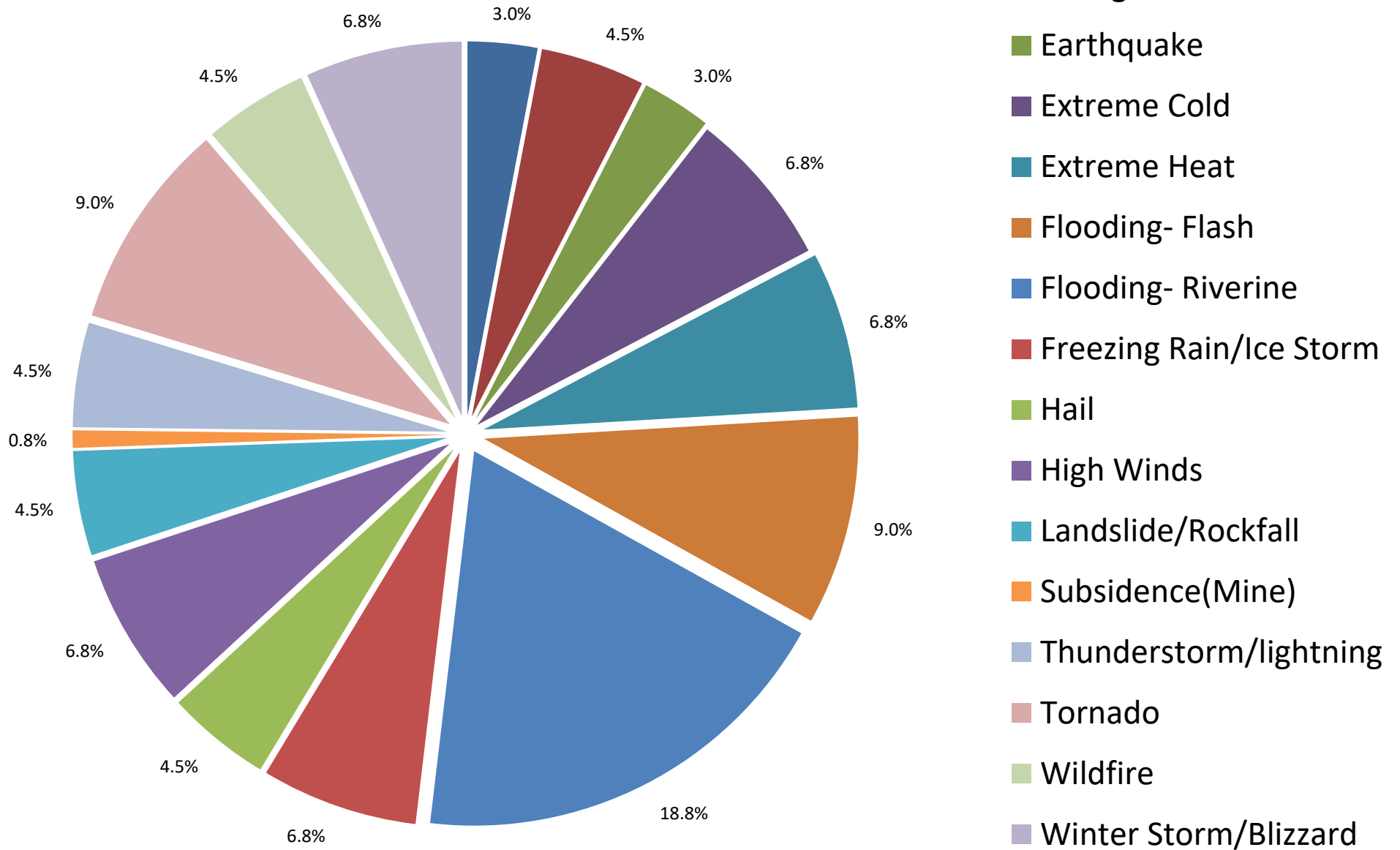
The City of Athens has 1023 residents aged 65+ years and an institutional population of 139.

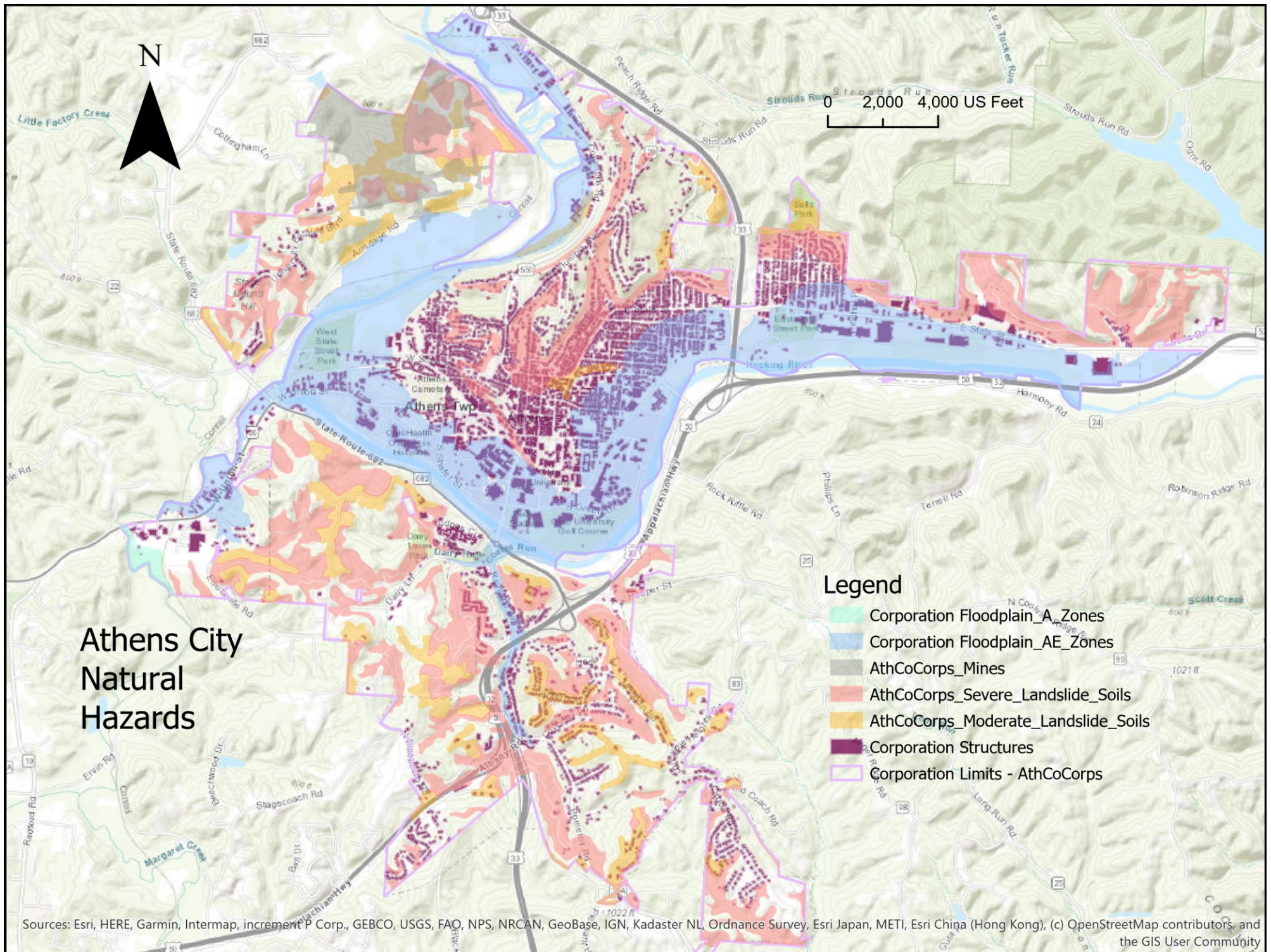
New Development

- A large home and building supply store is being built on the east side of the City in the floodplain. Necessary permits were obtained.
- The City has made improvements to its WWTP.

ATHENS CITY									
Asset	Total	# in Floodplain	% in Floodplain	# in Landslide/ Moderate	% in Landslide/ Moderate	# in Landslide/Severe	% in Landslide/Severe	# in Subsidence	% in Subsidence
Land (acres)	6057.1	1671.7	28%	1752.6	29%	819.7	14%	250.1	4.1%
Population¹	24,688								
Residential Parcels	3594	578	16%	112	3%	1064	30%	0	0.0%
Commercial Parcels²	761	313	41%	46	6%	166	22%	1	0.1%
Industrial Parcels	8	3	38%						
600-880									
Structures³	5779	1344	23%	580	10%	2699	47%	0	
Developed Parcel Value	\$2,426,411,340	\$2,114,695,880	87%	\$67,169,840	3%	\$436,674,500	18%	\$101,220	0.0%
Institutional Population⁴	139								
Elderly 65+⁴	1023		Tornado	\$14,421,226			NOTES		
Repetitive Loss Properties	0		Tornado Contents	\$7,210,613			1. 2018 estimate		
Critical Facilities	31		Total Tornado	\$21,631,839			2. includes apartments with 4+ rental units		
							3. County LIDAR		
			Earthquake	\$349,403,233			4. 2010 census		

Athens City Natural Hazards Relative Risk





2.3.6 Athens County (unincorporated)

Key Facts

- Athens County is rural with a low population density and land cover that is primarily forest.
- Athens County has 2,284 structures (5.8%) in the floodplain.
- 42% of the land in Athens County is in moderate landslide areas and 17.6 % in in severe landslide areas.
- 11.4 % of the land area in Athens County is in subsidence zones. 4,714 structures are in subsidence zones.
- Athens County completed two mitigation projects: one for \$226,479 in Sugar Creek that was used for acquisition and dry floodproofing and one for \$841,429 in Doanville (York Township) for acquisition.

Assets

The unincorporated region of Athens County contains 39,116 structures and a developed parcel value of \$1,451,730,790.

Critical Facilities

- York Twp. VFD
- Leax WTP and wellfield
- Burr Oak Lake dam
- GTJ WWTP
- Sunday Creek WTP and wellfields
- Waterloo VFD
- Fox Lake dam
- Richland Area VFD
- AEP substation on Strouds Run Rd.
- Dow Lake dam
- Rome Twp. VFD
- Township garages in Waterloo, Dover, Bern, York, Canaan, Rome, Alexander, Lodi, and Carthage Townships
- Nesbitt dam
- Lake Snowden dam
- Oxley Rd. Lake dam

Hazard	Potential Damages	Injury/Death
Dam Failure	\$24,285,424	Likely
Drought	\$2,286,400	Unlikely
Earthquake	\$209,049,234	Likely
Extreme Cold	\$40,000	Possible
Extreme Heat	Minor <\$10,000	Likely
Flooding (Flash)	\$100,000	Possible
Flooding (Riverine)	\$22,077,659	Likely
Freezing Rain/Ice Storm	\$40,000	Possible
Hail	\$40,000	Unlikely
High Winds	\$100,000	Possible
Invasive Species	Moderate	None
Landslide/Rockfall	\$6,395,000	None
Land Subsidence (mines)	Moderate \$10,000-\$50,000	Possible
Thunderstorms/Lightning	\$40,000	Possible
Tornado	\$250,617 (may be much higher if in a populated area)	Likely
Wildfire	Minor	Unlikely
Winter Storms/Blizzard	\$100,000	Possible

- Fisher Rd. Lake dam
- Meek's Lake dam
- Tennessee Gas pumping station and pipelines
- Texas Eastern pumping station and pipelines
- Carthage VFD

Vulnerabilities

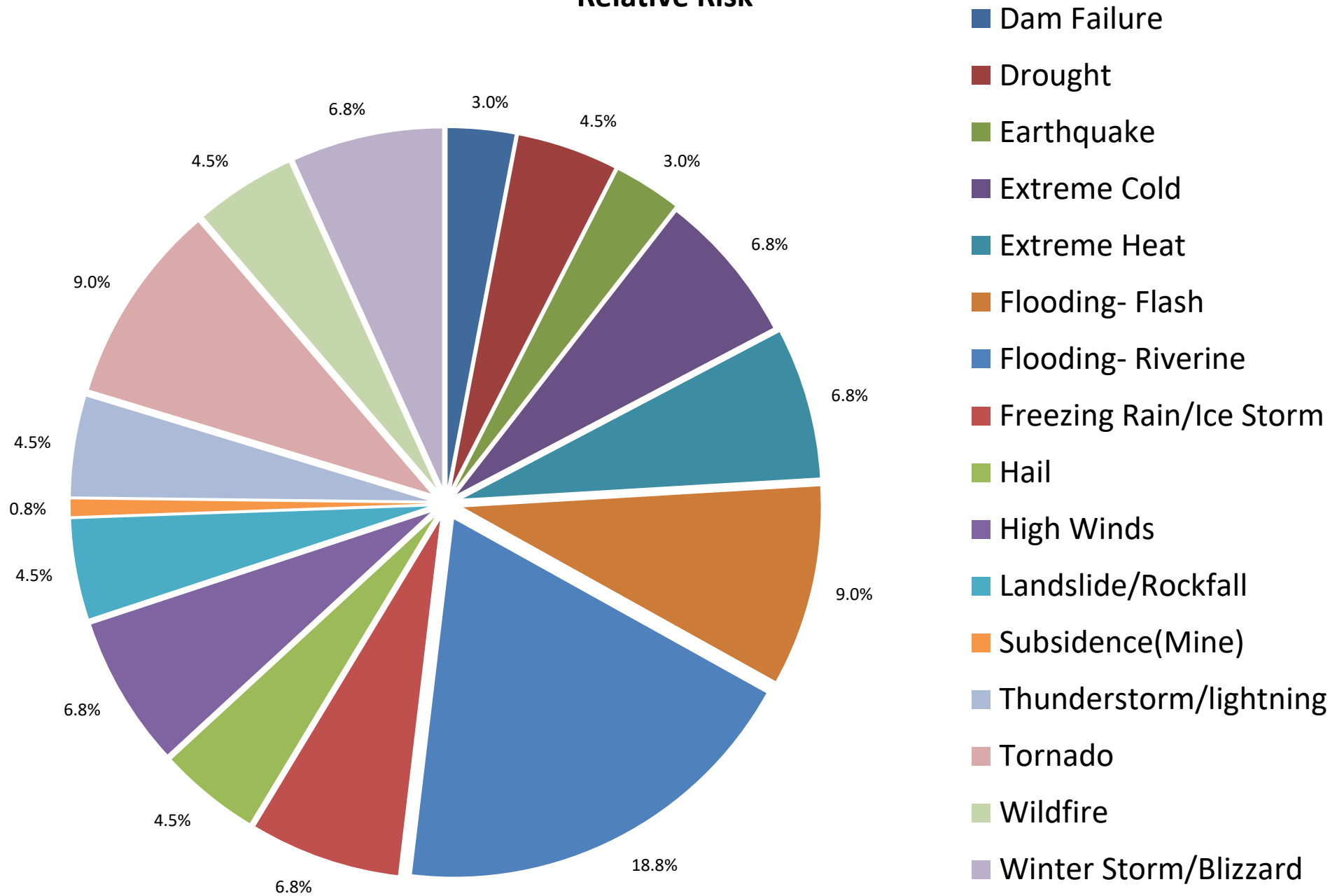
Unincorporated Athens County has 4,208 residents aged 65+ years and an institutional population of 218.

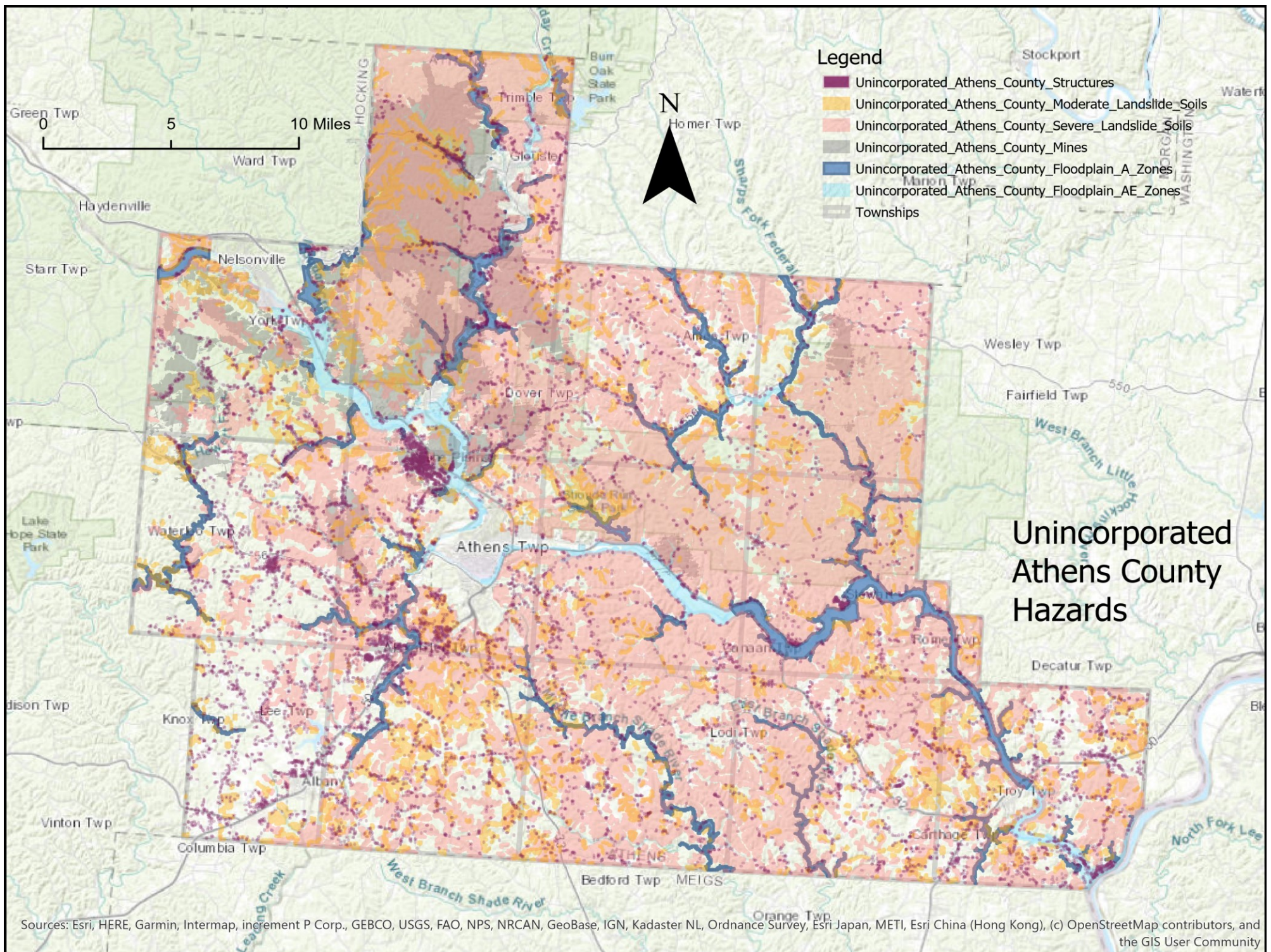
New Development

- A 1.3 mile extension to the Hockhocking Adena Bikeway was completed in 2019.
- ODOT has a new county highway garage in the same location as the old one.

ATHENS COUNTY (UNINC.)									
Asset	Total	# in Floodplain	% in Floodplain	# in Landslide/Moderate	% in Landslide/Moderate	# in Landslide/Severe	% in Landslide/Severe	# in Subsidence	% in Subsidence
Land (acres)	312,801.80	16,127.10	5.2%	131353.4	42.0%	55108.1	17.6%	35558.8	11.4%
Population¹	30,109		0.0%		0.0%		0.0%		0.0%
Residential Parcels	9917	1106	11.2%	1589	16.0%	4626	46.6%	2051	20.7%
Commercial Parcels²	410	117	28.5%	32	7.8%	60	14.6%	95	23.2%
Industrial Parcels	12	3	25.0%	5	41.7%	3	25.0%	1	8.3%
600-880									
Structures³	39116	2284	5.8%	2978	7.6%	4906	12.5%	4714	12.1%
Developed Parcel Value	\$1,451,730,790	\$345,620,150	23.8%	\$488,332,730	33.6%	\$1,361,412,230	93.8%	\$496,741,760	34.2%
Institutional Population⁴	218								
Elderly 65+⁴	4208		Tornado	\$167,078			NOTES		
Repetitive Loss Properties	17		Tornado Contents	\$83,539			1. 2018 estimate		
Critical Facilities	20		Total Tornado	\$250,617			2. includes apartments with 4+ rental units		
							3. County LIDAR		
			Earthquake	\$209,049,234			4. 2010 census		

Athens County Natural Hazards Relative Risk





2.3.7 Buchtel Village

Key Facts

- Buchtel has 45.8% of its land and 50.7% of its structures in the floodplain.
- Buchtel only has A-zone status for its floodplain areas and an updated flood map is needed.
- 23.4% of Buchtel lies in a subsidence zone, but only 4 structures are built in this zone.

Assets

The Village of Buchtel has 894 structures and developed parcels that total \$13,834,840.

Critical Facilities

- SR 685 bridge
Village hall and yard
- Happy Hollow bridge

Vulnerabilities

Buchtel has a population of 82 aged 65+ years and 1 repetitive loss property.

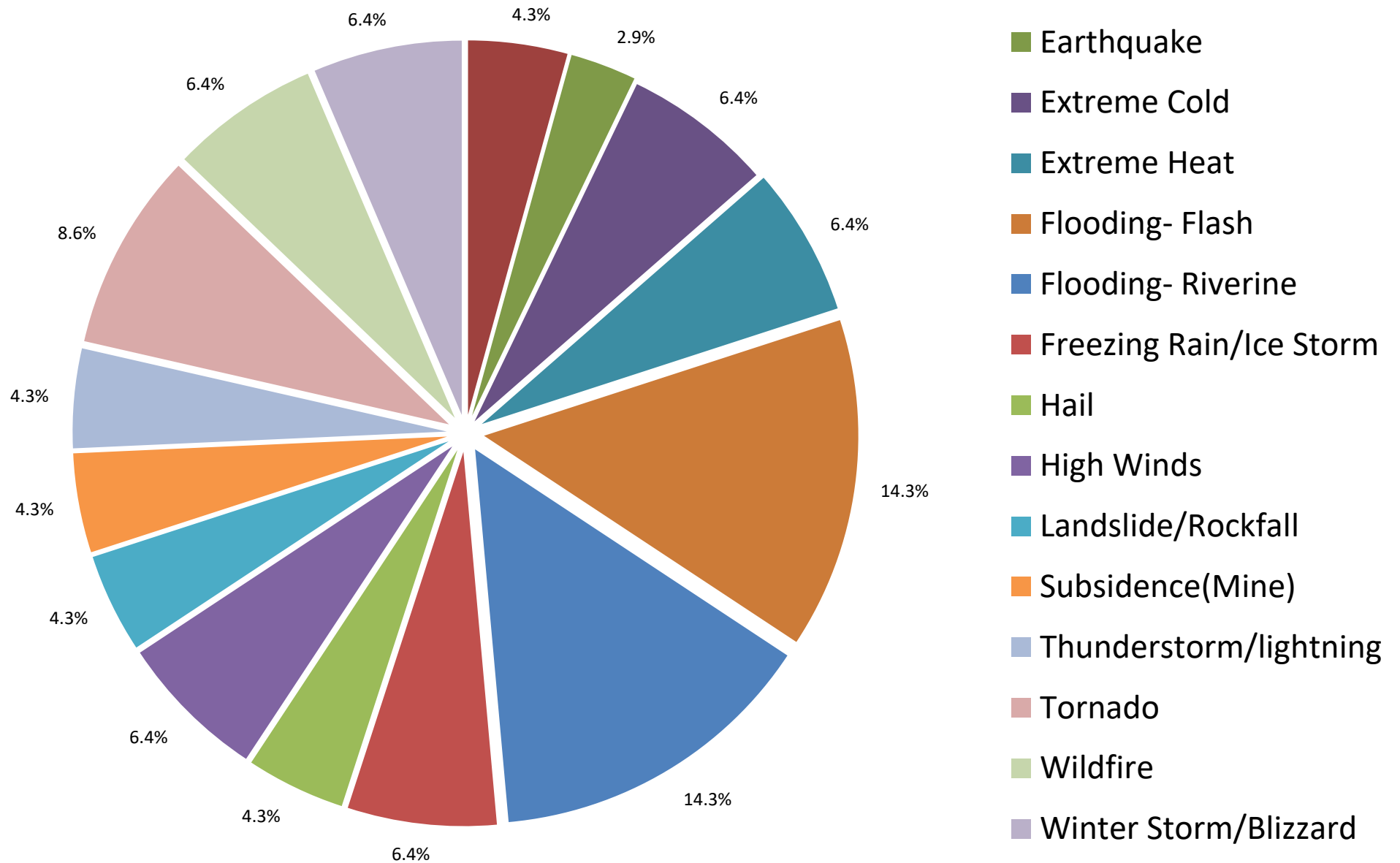
New Development

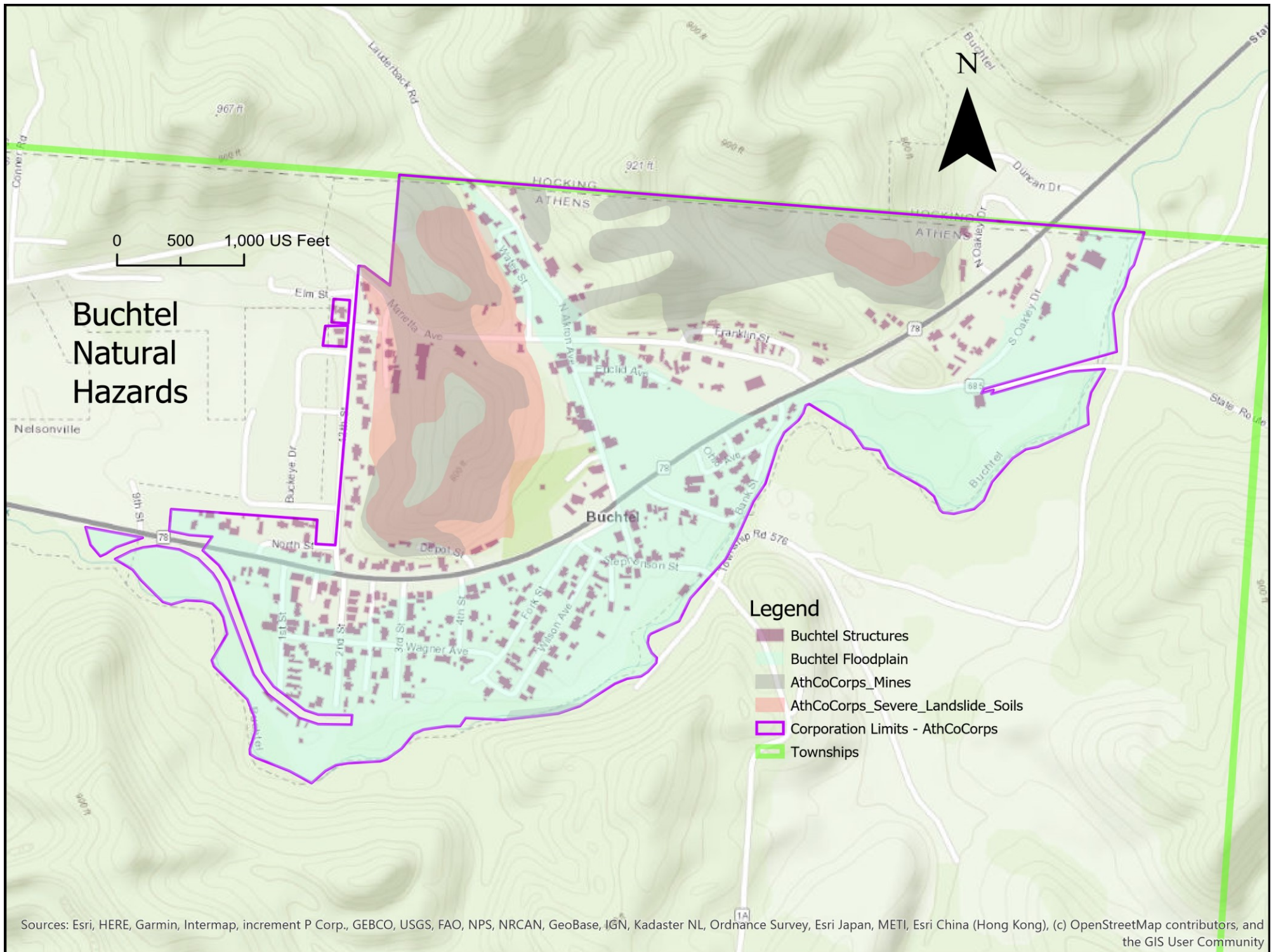
There is no new development in Buchtel.

Hazard	Potential Damages	Injury/Death
Dam Failure	No hazard	None
Drought	Minor <\$10,000	Unlikely
Earthquake	\$1,992,217	Likely
Extreme Cold	\$10,000	Possible
Extreme Heat	Minor <\$10,000	Likely
Flooding (Flash)	\$25,000	Unlikely
Flooding (Riverine)	\$1,957,765	Possible
Freezing Rain/Ice Storm	\$10,000	Possible
Hail	\$10,000	Unlikely
High Winds	\$25,000	Possible
Invasive Species	Minor	None
Landslide/Rockfall	\$47,000	None
Land Subsidence (mines)	Moderate \$10,000-\$50,000	Unlikely
Thunderstorms/Lightning	\$10,000	Possible
Tornado	\$1,974,468	Likely
Wildfire	Minor	Unlikely
Winter Storms/Blizzard	\$25,000	Possible

BUCHTEL									
Asset	Total	# in Floodplain	% in Floodplain	# in Landslide/ Moderate	% in Landslide/ Moderate	# in Landslide/ Severe	% in Landslide/Severe	# in Subsidence	% in Subsidence
Land (acres)	272.9	125.1	45.8%	41.9	15%	2.9	1.1%	63.9	23.4%
Population¹	551								
Residential Parcels	194	108	55.7%	0	0%	28	14.4%	21	10.8%
Commercial Parcels²	7	6	85.7%	0	0%	0	0.0%	0	0.0%
Industrial Parcels									
600-880									
Structures³	894	453	50.7%	0		47	5.3%	4	0.4%
Developed Parcel Value	\$13,834,840	\$9,453,770	68.3%	\$ -		\$1,588,360	11.5%	\$1,963,250	14.2%
Institutional Population⁴	0								
Elderly 65+⁴	82		Tornado	\$1,825,043			NOTES		
Repetitive Loss Properties	1		Tornado Contents	\$912,522			1. 2018 estimate		
Critical Facilities	3		Total Tornado	\$2,737,565			2. includes apartments with 4+ rental units		
							3. County LIDAR		
			Earthquake	\$1,992,217			4. 2010 census		

Buchtel Natural Hazards Relative Risk





2.3.8 Chauncey Village

Key Facts

- Chauncey has 62.2% of its land and 53.8% of its structures in the floodplain.
- Chauncey does not participate in the National Flood Insurance Program.
- Chauncey has 11 repetitive loss properties.

Assets

The Village of Chauncey has 842 structures and a developed parcel value of \$18,719,520.

Critical Facilities

- Chauncey WWTP
- Chauncey WTP
- Dover VFD
- Water tower

Vulnerabilities

Chauncey has a population of 139 aged 65+ years and 11 repetitive loss properties.

New

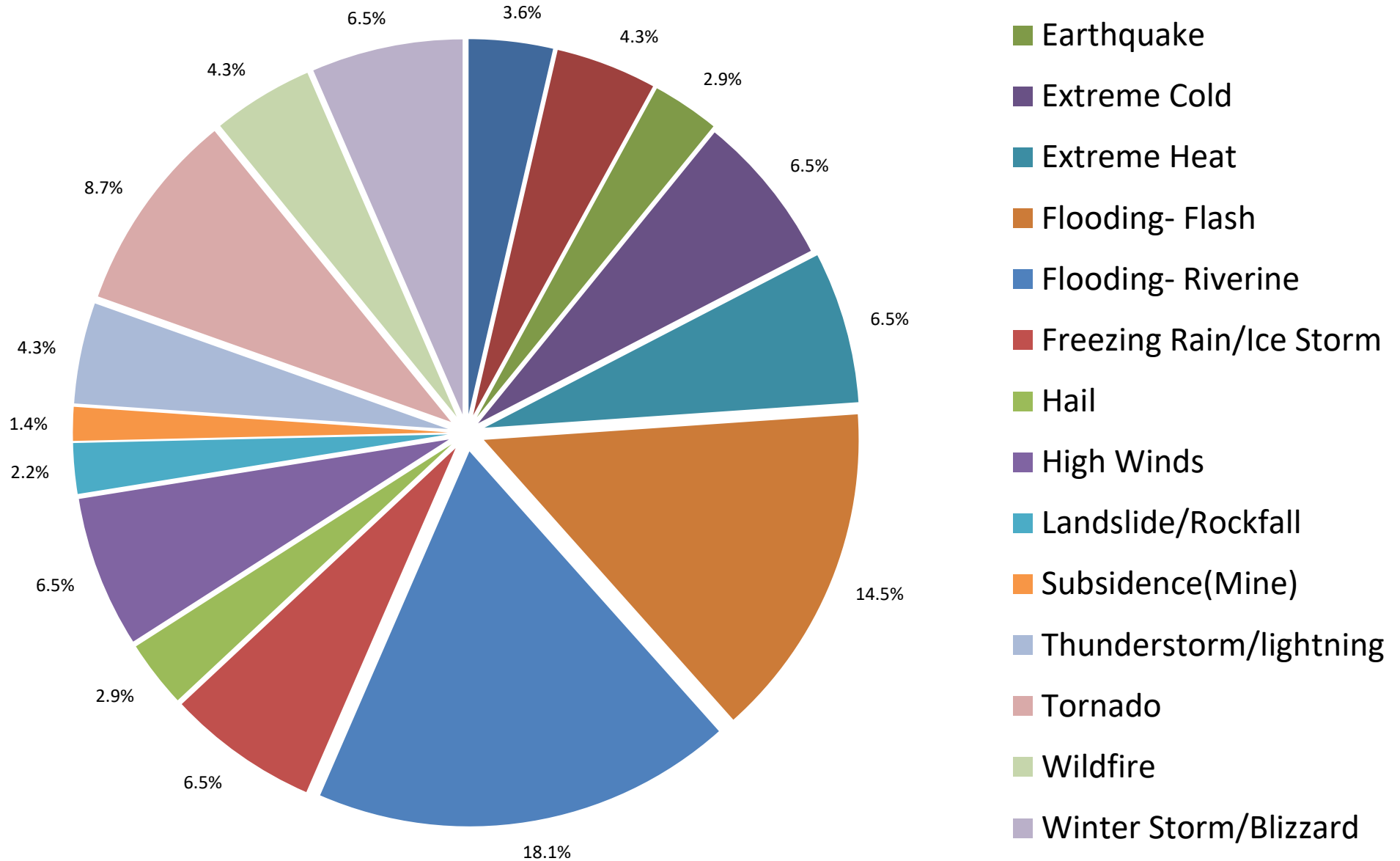
Development

Chauncey is going to be the staging/access point for a new mountain bike facility on neighboring Wayne National Forest.

Hazard	Potential Damages	Injury/Death
Dam Failure	\$3,565,743	None
Drought	Minor <\$10,000	Unlikely
Earthquake	\$ 2,695,611	Likely
Extreme Cold	\$10,000	Possible
Extreme Heat	Minor <\$10,000	Likely
Flooding (Flash)	\$25,000	Unlikely
Flooding (Riverine)	\$2,971,452	None
Freezing Rain/Ice Storm	\$10,000	Possible
Hail	\$10,000	Unlikely
High Winds	\$25,000	Possible
Invasive Species	Minor	None
Landslide/Rockfall	\$0	None
Land Subsidence (mines)	Moderate \$10,000-\$50,000	Unlikely
Thunderstorms/Lightning	\$10,000	Possible
Tornado	\$3,023,793	Likely
Wildfire	Minor	Unlikely
Winter Storms/Blizzard	\$25,000	Possible

CHAUNCEY									
Asset	Total	# in Floodplain	% in Floodplain	# in Landslide/Moderate	% in Landslide/Moderate	# in Landslide/Severe	% in Landslide/Severe	# in Subsidence	% in Subsidence
Land (acres)	334.3	207.9	62.2%	3.4	1%	6.9	2%	8.9	2.7%
Population¹	1,045								
Residential Parcels	330	191	57.9%	0	0%	0	0%	2	0.6%
Commercial Parcels²	15	9	60.0%	0	0%	0	0%	1	6.7%
Industrial Parcels									
600-880									
Structures³	842	453	53.8%					4	0.5%
Developed Parcel Value	\$18,719,520	\$11,267,980	60.2%	\$ -	0%	\$ -	0%	\$219,790	1.2%
Institutional Population⁴	0								
Elderly 65+⁴	139		Tornado	\$2,015,862			NOTES		
Repetitive Loss Properties	11		Tornado Contents	\$1,007,931			1. 2018 estimate		
Critical Facilities	4		Total Tornado	\$3,023,793			2. includes apartments with 4+ rental units		
							3. County LIDAR		
			Earthquake	\$2,695,611			4. 2010 census		

Chauncey Natural Hazards Relative Risk



Chauncey Natural Hazards

0 1,000 2,000 US Feet



Legend

- Corporation Floodplain_A_Zones
- Corporation Floodplain_AE_Zones
- AthCoCorps_Mines
- Corporation Structures
- Corporation Limits - AthCoCorps

2.3.9 Coolville Village

Key Facts

- Coolville Village only has 5.4% of its land and 0% of its structures in the floodplain.
- 124 structures (23%) are in a severe landslide soil area.
- Coolville does not have any repetitive loss properties.

Assets

The Village of Coolville is fortunate to have been sited outside of flood zones and in an area that was never underground mined for coal. The Village contains 544 structures and has an improved parcel value of \$18,719,520.

Critical Facilities

- Troy Township garage and yard
- EMS
- Wastewater treatment system
- Water storage tank
- Coolville Health Clinic
- Telephone switching station
- Coolville Town Hall
- Coolville VFD

Hazard	Potential Damages	Injury/Death
Dam Failure	No hazard	None
Drought	Minor <\$10,000	Unlikely
Earthquake	\$3,016,882	Likely
Extreme Cold	\$10,000	Possible
Extreme Heat	Minor <\$10,000	Likely
Flooding (Flash)	Minor < \$10,000	Unlikely
Flooding (Riverine)	None	None
Freezing Rain/Ice Storm	\$10,000	Possible
Hail	\$10,000	Unlikely
High Winds	\$25,000	Possible
Invasive Species	Minor	None
Landslide/Rockfall	\$39,000	None
Land Subsidence (mines)	None	None
Thunderstorms/Lightning	\$10,000	Possible
Tornado	\$1,761,923	Likely
Wildfire	Minor	Unlikely
Winter Storms/Blizzard	\$25,000	Possible

Vulnerabilities

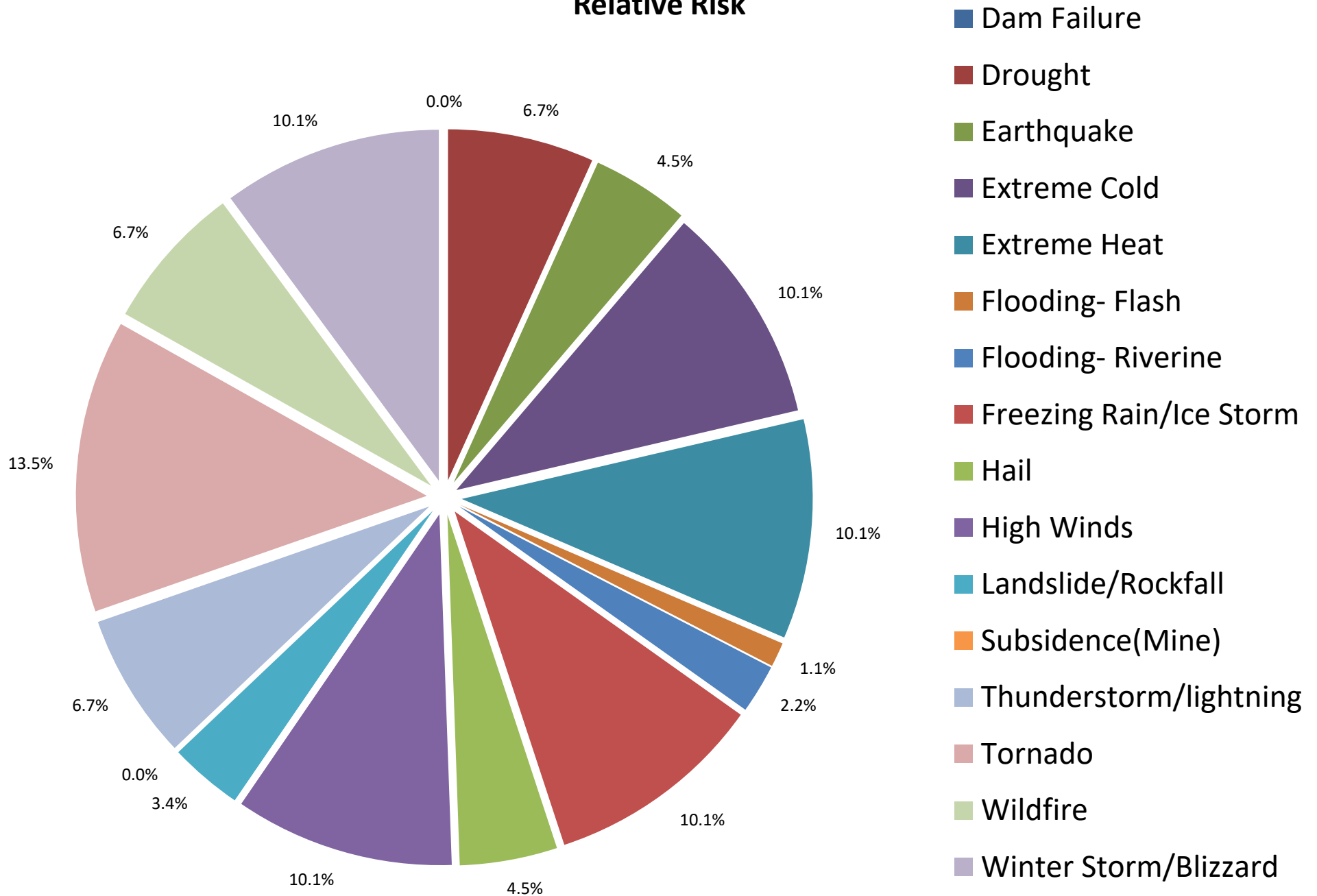
Coolville has a population of 63 aged 65+ years.

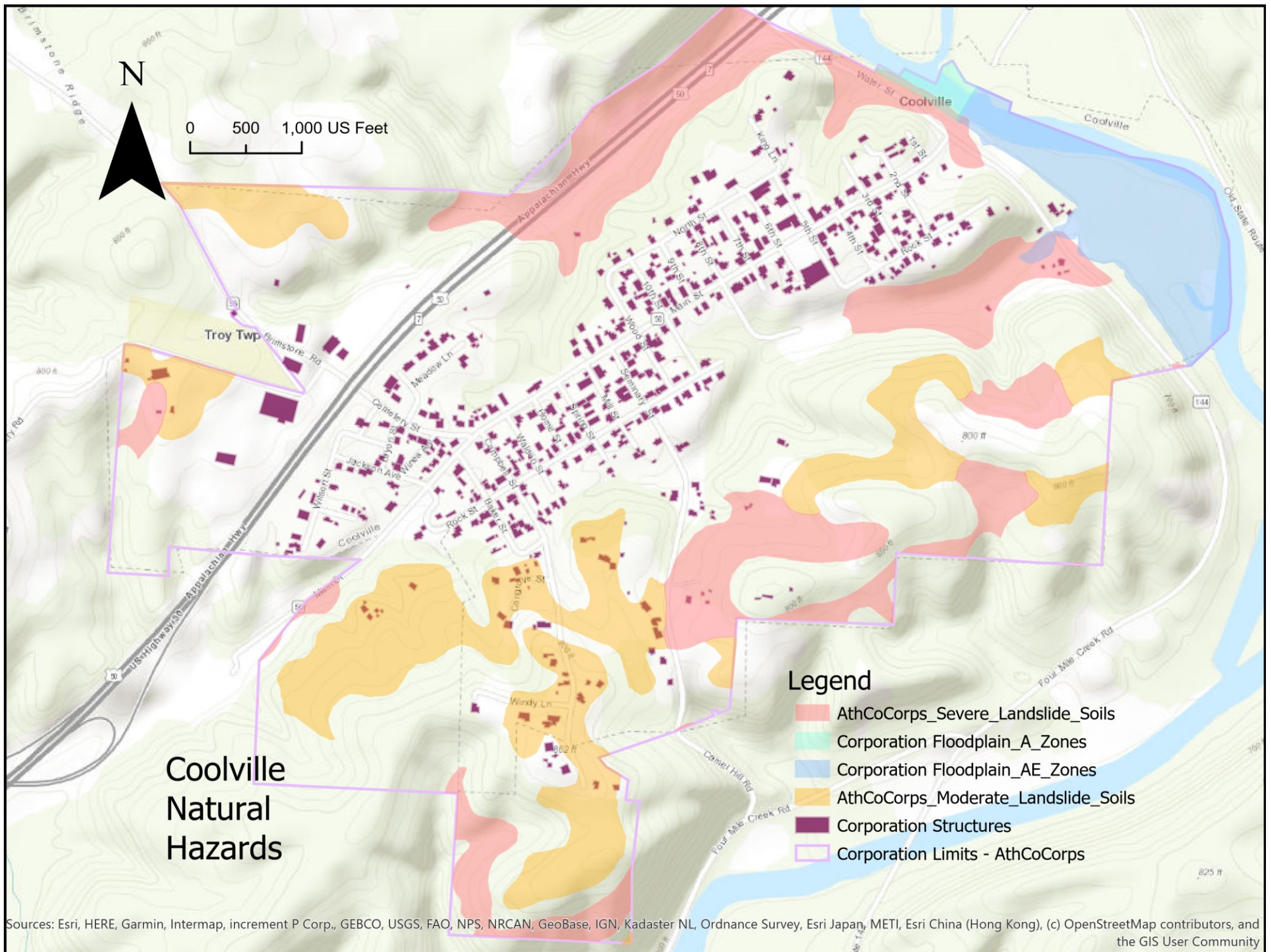
New Development

Coolville has a new wastewater treatment system.

COOLVILLE									
Asset	Total	# in Floodplain	% in Floodplain	# in Landslide/Moderate	% in Landslide/Moderate	# in Landslide/Severe	% in Landslide/Severe	# in Subsidence	% in Subsidence
Land (acres)	642.1	34.4	5.4%	156.2	24%	52.1	8%	0	0%
Population¹	498								
Residential Parcels	214	0	0.0%	25	12%	14	7%	0	0%
Commercial Parcels²	28	0	0.0%	1	4%	1	4%	0	0%
Industrial Parcels	1			1	100%				
600-880									
Structures³	544	0	0.0%	48	9%	124	23%	0	0%
Developed Parcel Value	\$18,719,520	\$ -		\$3,270,160	17%	\$1,536,440	8%	\$ -	0%
Institutional Population⁴	0								
Elderly 65+⁴	63		Tornado	\$1,049,529			NOTES		
Repetitive Loss Properties	0		Tornado Contents	\$524,765			1. 2018 estimate		
Critical Facilities	8		Total Tornado	\$1,574,294			2. includes apartments with 4+ rental units		
							3. County LIDAR		
			Earthquake	\$2,695,611			4. 2010 census		

Coolville Natural Hazards Relative Risk





2.3.10 Glouster Village

Key Facts

- Glouster has 84.3% of its commercial parcels and 443 or 26.5% of its structures in the floodplain.
- Glouster has 54.4% of its land and 783 or 46.8% of its structures in a subsidence zone.
- Glouster successfully completed a mitigation project after flooding in 2005. \$593,110 was awarded for acquisition.

Assets

The Village of Glouster has 1,672 structures and a developed parcel value of \$57,236,210.

Critical Facilities	Hazard	Potential Damages	Injury/Death
• Trimble Township building and yard	Dam Failure	\$5,341,070	None
	Drought	Minor <\$10,000	Unlikely
• Telephone switching station	Earthquake	\$8,242,014	Likely
	Extreme Cold	\$10,000	Possible
• High St. bridge	Extreme Heat	Minor <\$10,000	Likely
	Flooding (Flash)	\$25,000	Unlikely
• Madison St. bridge	Flooding (Riverine)	\$4,108,516	Likely
	Freezing Rain/Ice Storm	\$10,000	Possible
• Glouster FD	Hail	\$10,000	Unlikely
	High Winds	\$25,000	Possible
• Water reservoir	Invasive Species	Minor	None
	Landslide/Rockfall	\$121,000	None
• Village hall and PD	Land Subsidence (mines)	Moderate \$10,000-\$50,000	Unlikely
	Thunderstorms/Lightning	\$10,000	Possible
• Oak St. bridge	Tornado	\$3,804,007	Likely
	Wildfire	Minor	Unlikely
• Locust St. bridge	Winter Storms/Blizzard	\$25,000	Possible
• Main St. bridge			
• Embry Rd. bridge			
• Allen St. bridge			
• SR 78 bridge			

Vulnerabilities

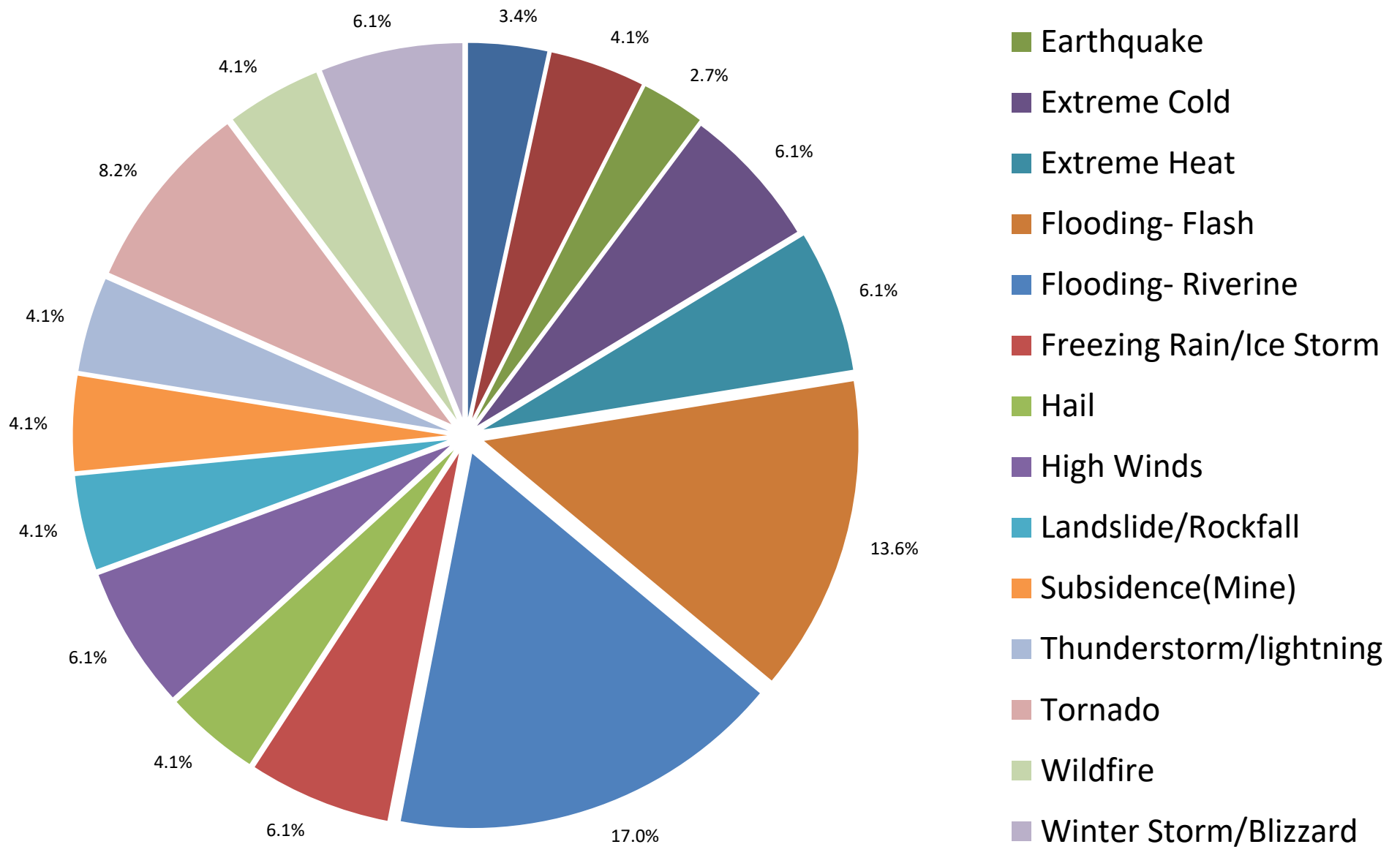
Glouster has a population of 213 aged 65+ years old and 7 repetitive loss properties.

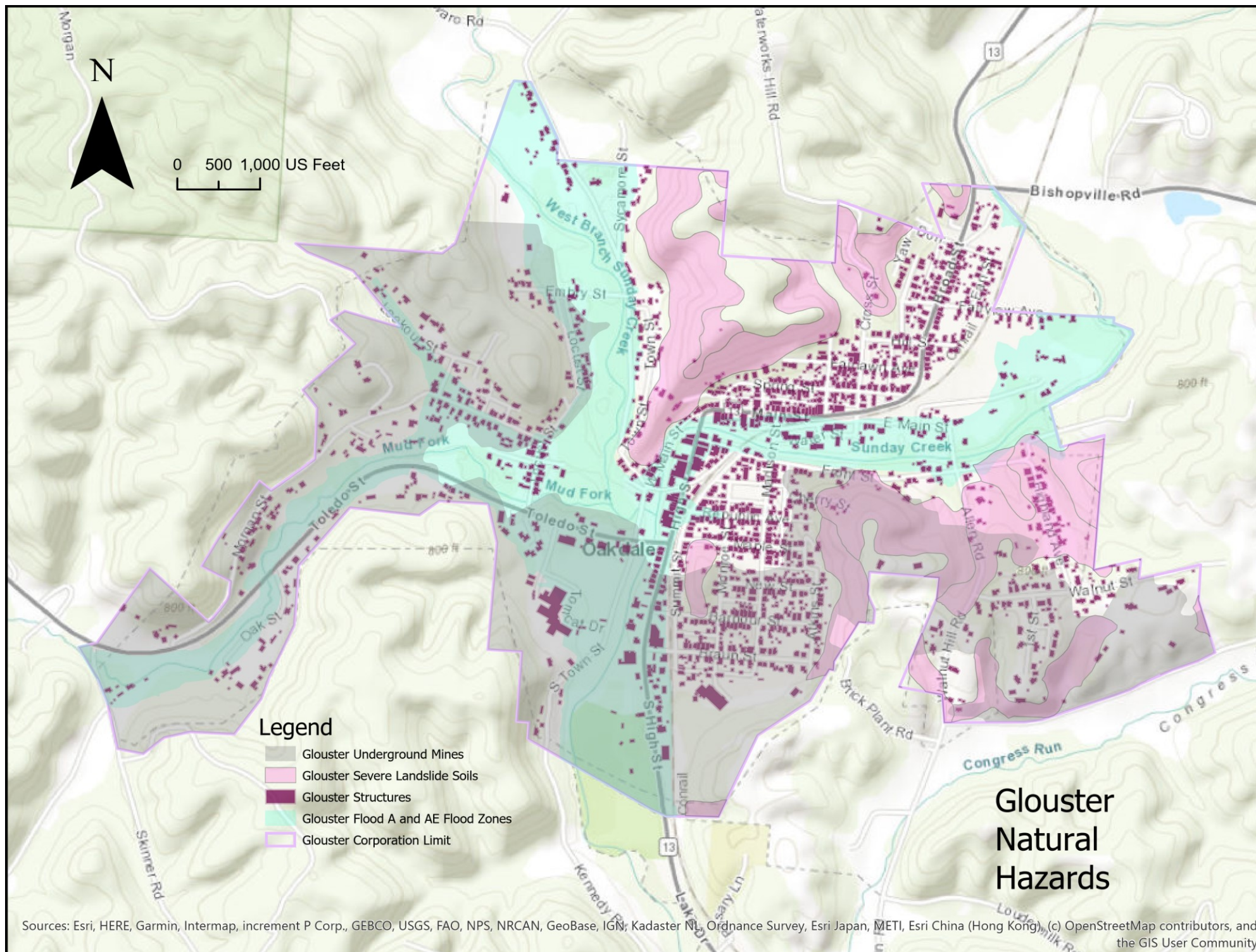
New Development

Locust St. bridge was replaced in 2019.

GLOUSTER									
Asset	Total	# in Floodplain	% in Floodplain	# in Landslide/Moderate	% in Landslide/Moderate	# in Landslide/Severe	% in Landslide/Severe	# in Subsidence	% in Subsidence
Land (acres)	812.5	246.7	30.4%	213.5	26.3%	142	17.5%	441.8	54.4%
Population¹	1,795								
Residential Parcels	810	291	35.9%	3	0.4%	156	19.3%	381	47.0%
Commercial Parcels²	89	75	84.3%	0	0.0%	2	2.2%	29	32.6%
Industrial Parcels	2	2	100.0%						
600-880									
Structures³	1672	443	26.5%	0	0.0%	121	7.2%	783	46.8%
Developed Parcel Value	\$57,236,210	\$42,354,190	74.0%	\$226,250	0.4%	\$6,931,320	12.1%	\$47,186,650	82.4%
Institutional Population⁴	0								
Elderly 65+⁴	213		Tornado	\$2,536,004			NOTES		
Repetitive Loss Properties	7		Tornado Contents	\$1,268,002			1. 2018 estimate		
Critical Facilities	13		Total Tornado	\$3,804,007			2. includes apartments with 4+ rental units		
							3. County LIDAR		
			Earthquake	\$8,242,014			4. 2010 census		

Glouster Natural Hazards Relative Risk





Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

2.3.11 Jacksonville Village

Key Facts

- Jacksonville has 33.8% of its land, five of its seven commercial properties, and 155 or 30.4% of its structures in the floodplain.
- Jacksonville needs to have its flood maps updated to show AE zones and a floodway.
- Jacksonville has 48% of its land and 64% of its structures located in a subsidence zone.

Assets

Jacksonville has 510 structures and a developed parcel value of \$10,003,250.

Critical Facilities

- Jacksonville VFD
- Water tank

Vulnerabilities

Jacksonville has a population of 88 aged 65+ years old and 2 repetitive loss properties.

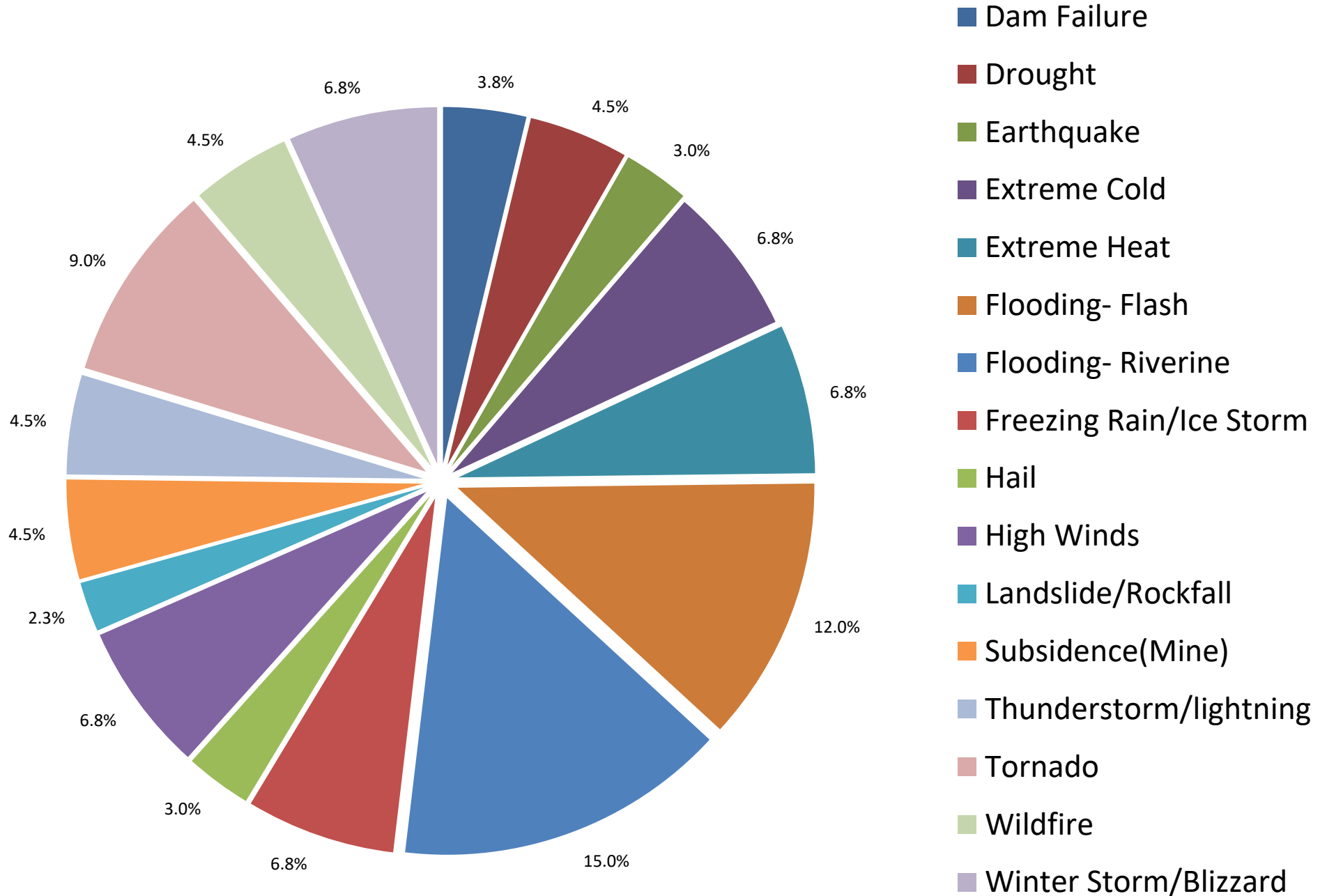
New Development

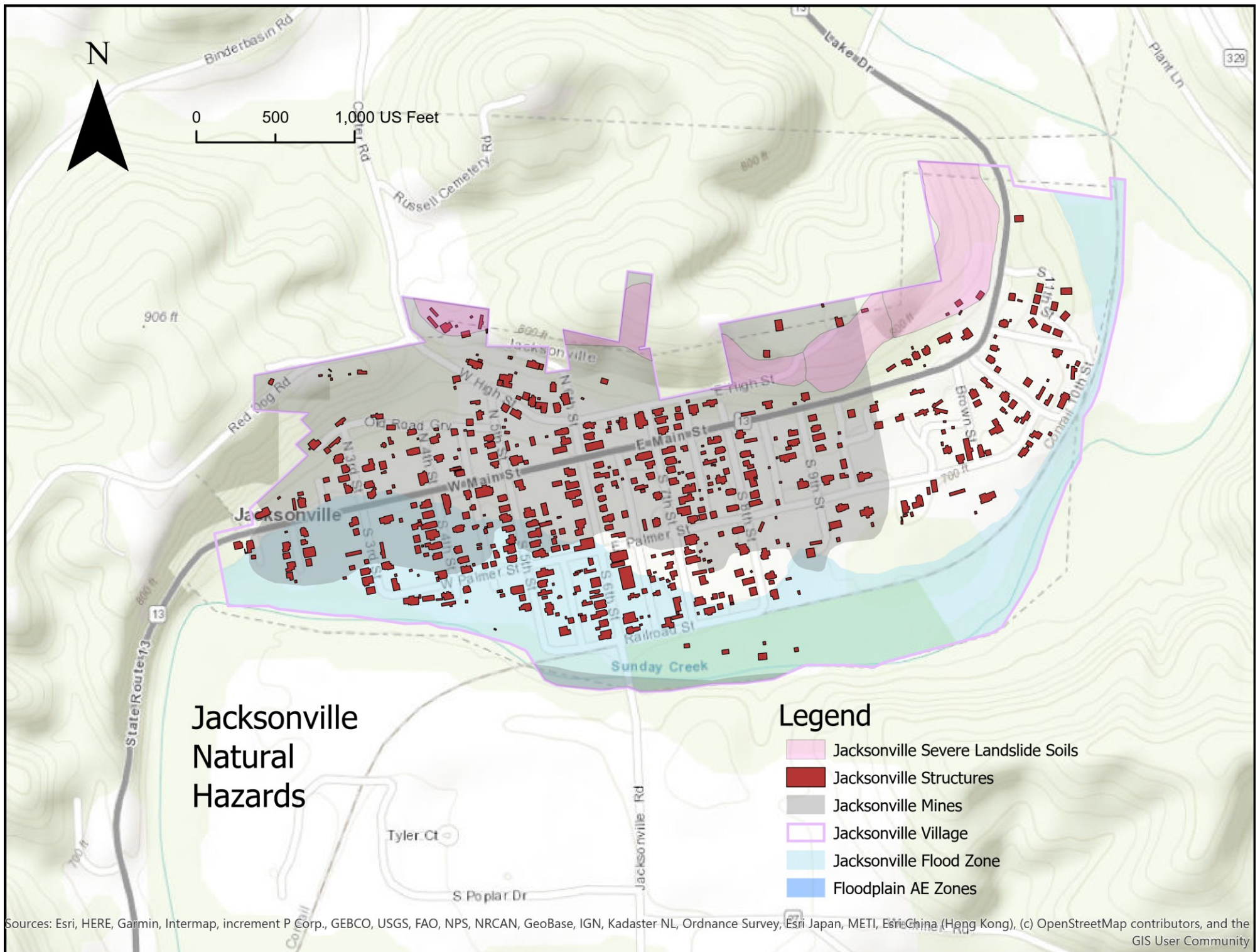
There is no new development in Jacksonville.

Hazard	Potential Damages	Injury/Death
Dam Failure	\$1,138,660	Likely
Drought	Minor <\$10,000	Unlikely
Earthquake	\$1,440,468	Likely
Extreme Cold	\$10,000	Possible
Extreme Heat	Minor <\$10,000	Likely
Flooding (Flash)	\$25,000	Unlikely
Flooding (Riverine)	\$875,892	Likely
Freezing Rain/Ice Storm	\$10,000	Possible
Hail	\$10,000	Unlikely
High Winds	\$25,000	Possible
Invasive Species	Minor	None
Landslide/Rockfall	\$0	None
Land Subsidence (mines)	Moderate \$10,000-\$50,000	Unlikely
Thunderstorms/Lightning	\$25,000	Possible
Tornado	\$3,471,565	Likely
Wildfire	Minor	Unlikely
Winter Storms/Blizzard	\$25,000	Possible

JACKSONVILLE									
Asset	Total	# in Floodplain	% in Floodplain	# in Landslide/Moderate	% in Landslide/Moderate	# in Landslide/Severe	% in Landslide/Severe	# in Subsidence	% in Subsidence
Land (acres)	155.6	52.6	33.8%	17	11%	32.9	21.1%	74.7	48%
Population¹	488								
Residential Parcels	253	82	32.4%	0	0%	8	3.2%	179	71%
Commercial Parcels²	7	5	71.4%	0	0%	0	0.0%	4	57%
Industrial Parcels									
600-880									
Structures³	510	155	30.4%					323	63%
Developed Parcel Value	\$10,003,250	\$3,392,990	33.9%	\$ -	0%	\$668,070	6.7%	\$7,404,670	74%
Institutional Population⁴	0								
Elderly 65+⁴	88		Tornado	\$2,314,377			NOTES		
Repetitive Loss Properties	2		Tornado Contents	\$1,157,188			1. 2018 estimate		
Critical Facilities	2		Total Tornado	\$3,471,565			2. includes apartments with 4+ rental units		
							3. County LIDAR		
			Earthquake	\$1,440,468			4. 2010 census		

Jacksonville Natural Hazards Relative Risk





Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

2.3.12 Nelsonville City

Key Facts

- Nelsonville has 34.2% of its land and 42.8% of its structures in the floodplain.
- Nelsonville has 20.0% of its land but only 1.2% of its structures in a subsidence zone.
- Nelsonville is home to Hocking College. There is a group quarters, non-institutionalized population of 691, primarily due to dormitories on campus.
- Nelsonville just acquired five flood mitigation parcels through Project 4098.15R.

Assets

Nelsonville has 2,965 structures and a developed parcel value of \$243,868,050.

Critical Facilities

- Nelsonville FD, PD, and City Hall
- 911 radio tower
- Nelsonville WTP
- Nelsonville WWTP
- Columbia Gas transmission
- EMS
- SR 278 bridge
- Hospital
- Water storage tank
- Hocking Parkway bridge
- SR 691 bridge

Hazard	Potential Damages	Injury/Death
Dam Failure	No hazard	None
Drought	Minor <\$10,000	Unlikely
Earthquake	\$35,116,999	Likely
Extreme Cold	\$20,000	Possible
Extreme Heat	Minor <\$10,000	Likely
Flooding (Flash)	\$50,000	Possible
Flooding (Riverine)	\$27,215,590	None
Freezing Rain/Ice Storm	\$20,000	Possible
Hail	\$20,000	Unlikely
High Winds	\$50,000	Possible
Invasive Species	Minor	None
Landslide/Rockfall	\$634,500	None
Land Subsidence (mines)	None	None
Thunderstorms/Lightning	\$20,000	Possible
Tornado	\$4,355,795	Likely
Wildfire	Minor	Unlikely
Winter Storms/Blizzard	\$50,000	Possible

Vulnerabilities

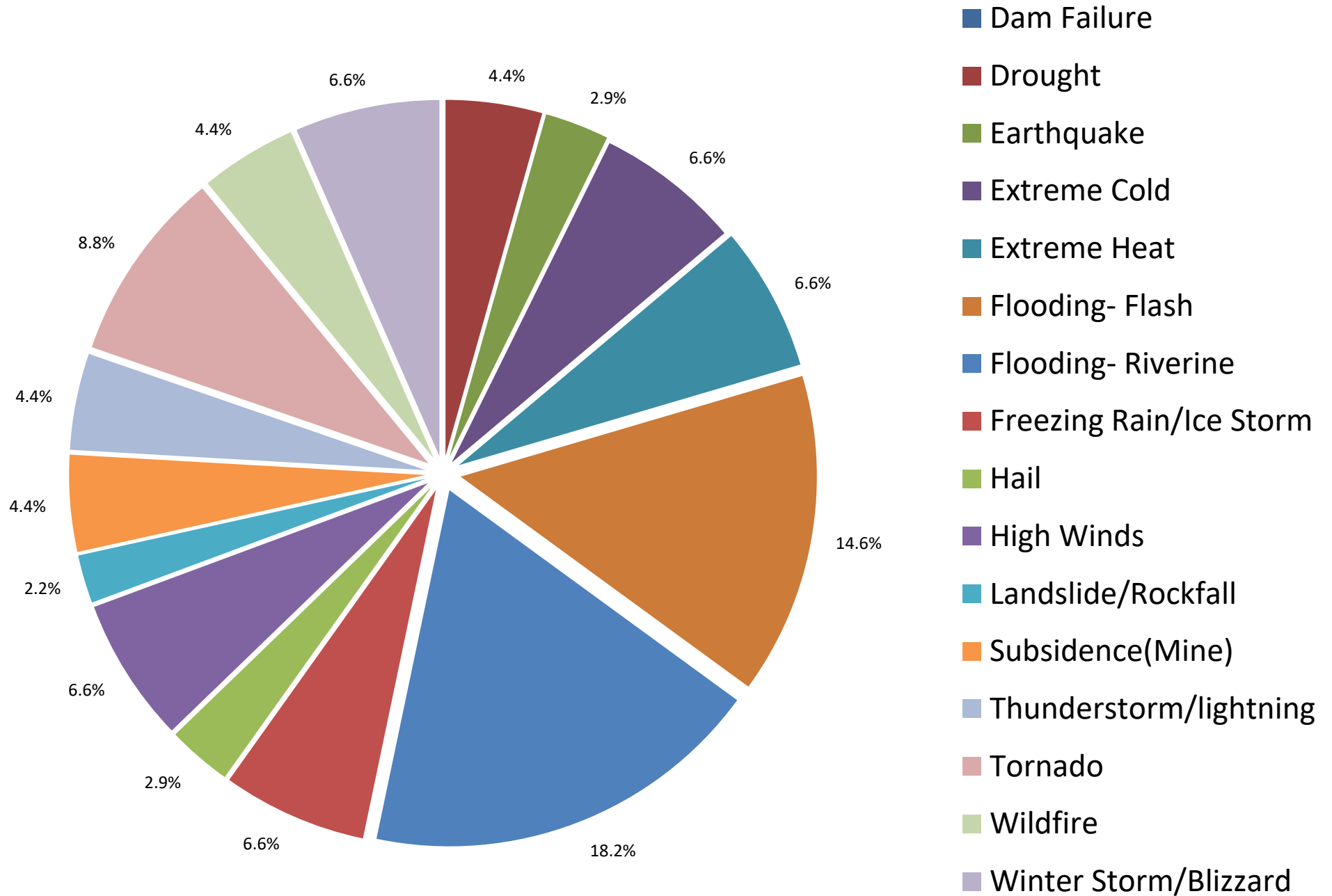
Nelsonville has a population of 484 aged 65+ years and 3 repetitive loss properties.

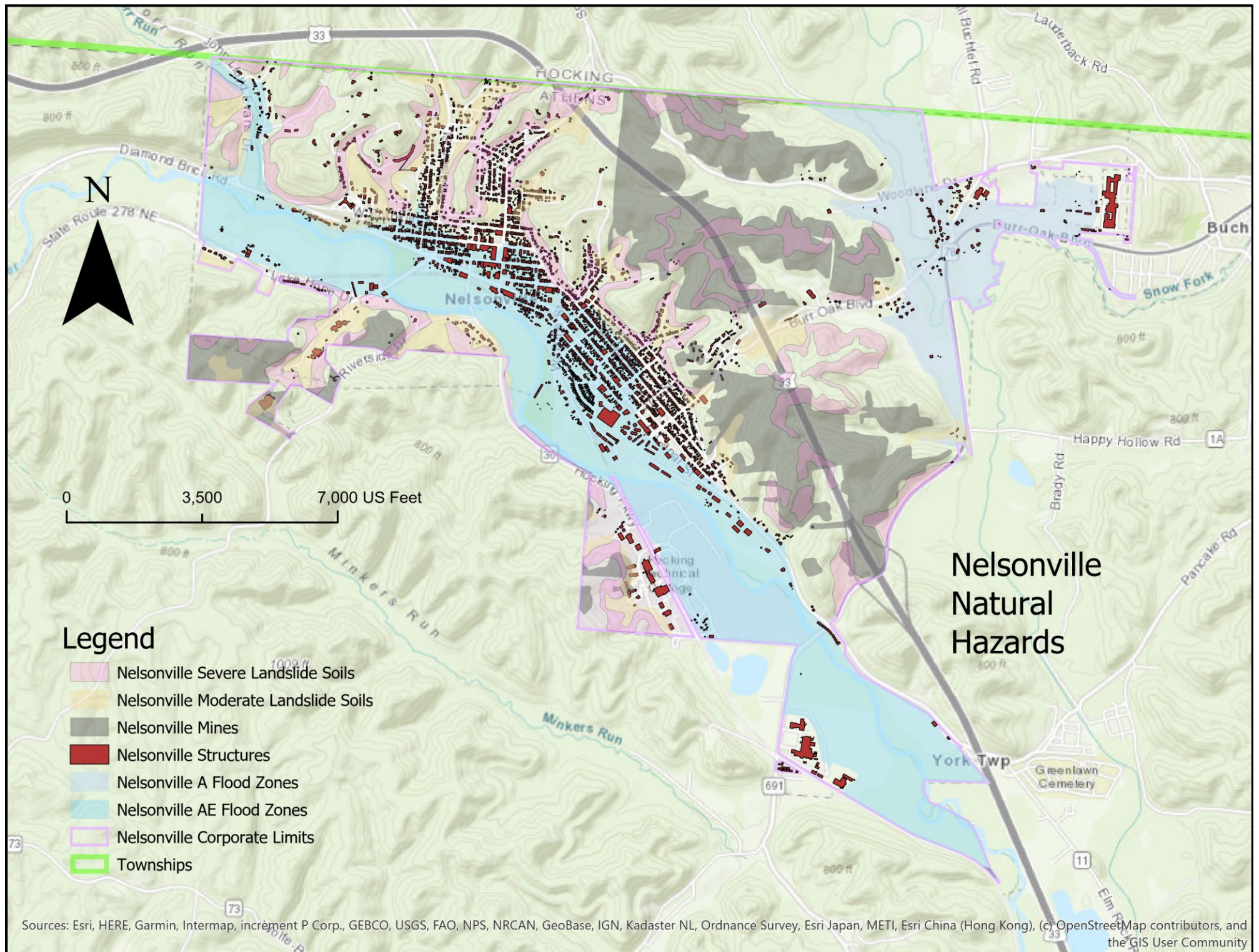
New Development

The state of Ohio recently closed a medium security prison in Nelsonville so the census figure of 300 institutionalized residents is no longer valid.

NELSONVILLE									
Asset	Total	# in Floodplain	% in Floodplain	# in Landslide/Moderate	% in Landslide/Moderate	# in Landslide/Severe	% in Landslide/Severe	# in Subsidence	% in Subsidence
Land (acres)	3023.3	1034.2	34.2%	597.8	19.8%	73.9	2.4%	606.1	20.0%
Population¹	5,183								
Residential Parcels	1557	597	38.3%	335	21.5%	390	25.0%	26	1.7%
Commercial Parcels²	277	210	75.8%	20	7.2%	15	5.4%	12	4.3%
Industrial Parcels	1								
600-880									
Structures³	2965	1268	42.8%	395	13.3%	437	14.7%	36	1.2%
Developed Parcel Value	\$243,868,050	\$201,912,820	82.8%	\$110,628,060	45.4%	\$83,505,890	34.2%	\$136,677,770	56.0%
Institutional Population⁴	300								
Elderly 65+⁴	484		Tornado	\$2,903,863			NOTES		
Repetitive Loss Properties	3		Tornado Contents	\$1,451,932			1. 2018 estimate		
Critical Facilities	11		Total Tornado	\$4,355,795			2. includes apartments with 4+ rental units		
							3. County LIDAR		
			Earthquake	\$35,116,999			4. 2010 census		

Nelsonville Natural Hazards Relative Risk





2.3.13 Trimble Village

Key Facts

- Trimble has 35% of its land, 13 or 100% of its commercial parcels, and 50.1% of its structures in a flood zone.
- 43.3% of its land and 83 or 18% of its structures are located in a moderate landslide soil.
- 83.7% of its land and 439 or 95.2% of its structures are located in a subsidence zone.
- Trimble was awarded and is in the process of completing a flood acquisition project for a total of 16 properties.

Assets

The Village of Trimble has 461 structures and an improved parcel value of \$ \$7,953,460.

Critical Facilities

- Water tank
- Congress Run bridges 1 and 2
- Walnut St. bridge
- E. Sycamore St. bridge
- Center St. bridge
- AEP substation
- SR 13 bridge

Vulnerabilities

Trimble has 62 persons aged 65+ years old and 14 repetitive loss properties.

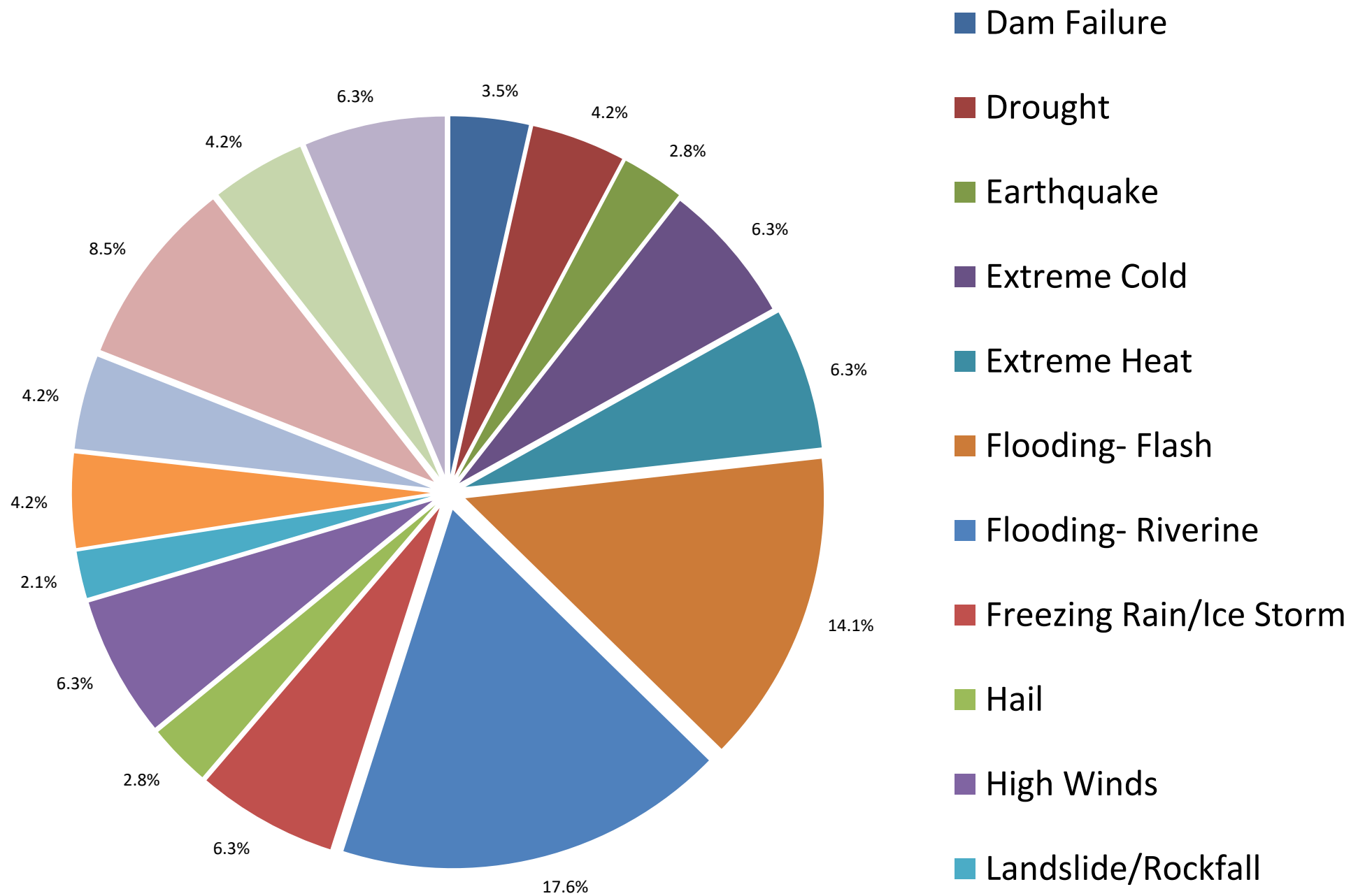
New Development

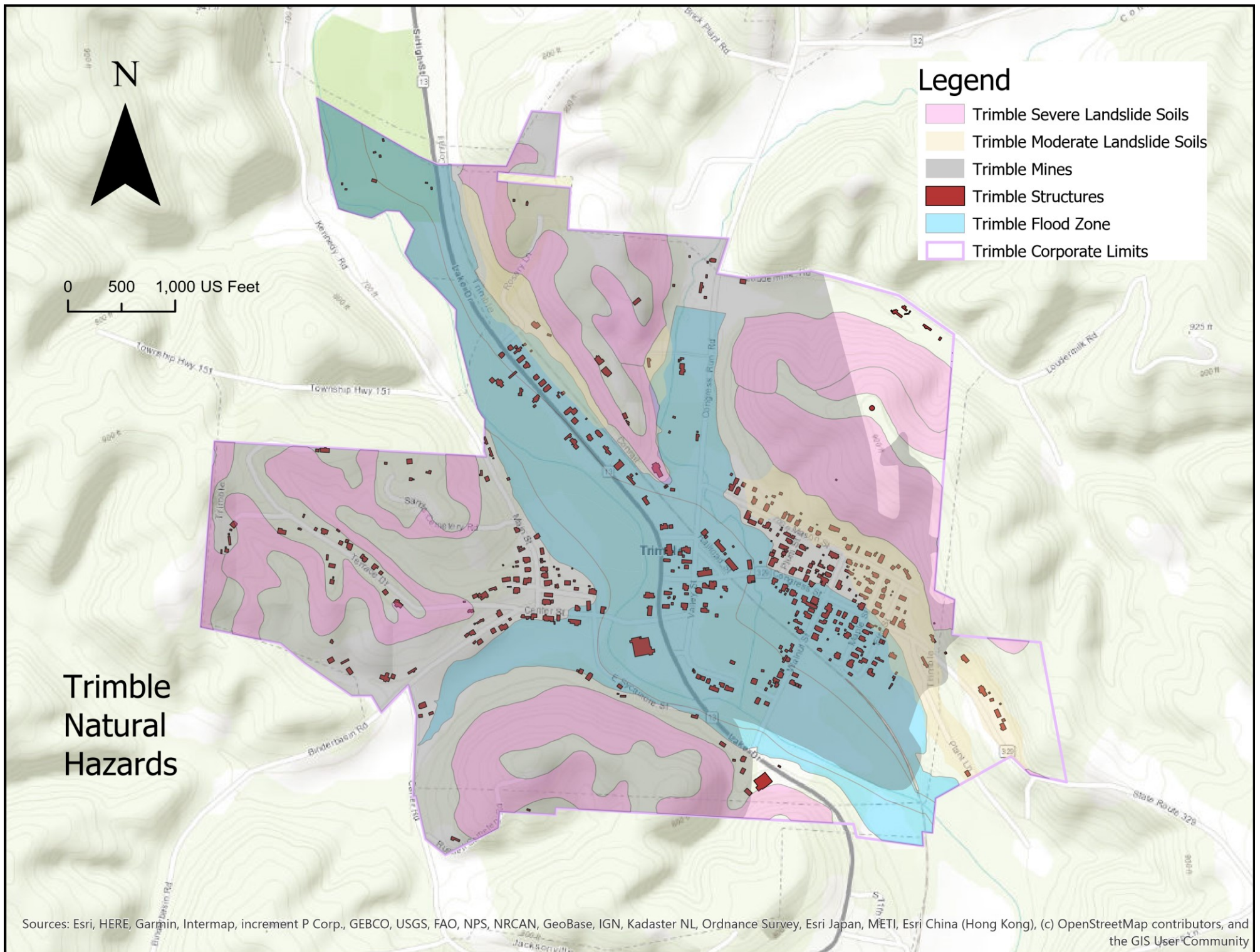
There is no new development in Trimble Village.

Hazard	Potential Damages	Injury/Death
Dam Failure	\$1,525,448	Likely
Drought	Minor <\$10,000	Unlikely
Earthquake	\$1,145,298	Likely
Extreme Cold	\$10,000	Possible
Extreme Heat	Minor <\$10,000	Likely
Flooding (Flash)	\$25,000	Unlikely
Flooding (Riverine)	\$1,173,421	Possible
Freezing Rain/Ice Storm	\$10,000	Possible
Hail	\$10,000	Unlikely
High Winds	\$25,000	Possible
Invasive Species	Minor	None
Landslide/Rockfall	\$57,500	Unlikely
Land Subsidence (mines)	Moderate \$10,000-\$50,000	Unlikely
Thunderstorms/Lightning	\$10,000	Possible
Tornado	\$967,749	Likely
Wildfire	Minor	Unlikely
Winter Storms/Blizzard	\$25,000	Possible

TRIMBLE									
Asset	Total	# in Floodplain	% in Floodplain	# in Landslide/ Moderate	% in Landslide/ Moderate	# in Landslide/ Severe	% in Landslide/Severe	# in Subsidence	% in Subsidence
Land (acres)	443.8	155.5	35.0%	192.2	43.3%	52	11.7%	371.5	83.7%
Population¹	403								
Residential Parcels	193	129	66.8%	49	25.4%	43	22.3%	188	97.4%
Commercial Parcels²	13	13	100.0%	0	0.0%	1	7.7%	13	100.0%
Industrial Parcels									
600-880									
Structures³	461	231	50.1%	83	18.0%	16	3.5%	439	95.2%
Developed Parcel Value	\$7,953,460	\$5,115,000	64.3%	\$1,890,760	23.8%	\$2,714,420	34.1%	\$7,807,900	98.2%
Institutional Population⁴	0								
Elderly 65+⁴	62		Tornado	\$645,166			NOTES		
Repetitive Loss Properties	14		Tornado Contents	\$322,583			1. 2018 estimate		
Critical Facilities	7		Total Tornado	\$967,749			2. includes apartments with 4+ rental units		
							3. County LIDAR		
			Earthquake	\$1,145,298			4. 2010 census		

Trimble Natural Hazards Relative Risk





2.4 Future Potential Areas of Risk

The state of Ohio recognizes four areas of risk concern that merit some discussion:

- Future growth
- Harmful algal bloom
- Hydraulic fracturing
- Climate change

2.4.1 Future Growth

Rapid growth in portions of the state has lead to concern because public services can be overwhelmed and hazard mitigation principles can be overlooked or downplayed in the effort to get more growth and development. Growth in population in Athens County is expected to be slow and with enrollment at Ohio University expected to decrease over the next several years, it is possible for Athens County to experience a no growth period. There is only one large development for the near term and that is construction of a public sewer to the southwest of the City of Athens. While it may encourage slight growth, most of this area is not in a floodplain and the terrain is relatively level so that landslides are minimal. There are no underground mines in this area.

2.4.2 Harmful Algal Bloom (HAB)

While this issue is primarily related to Lake Erie and the Lake Erie watershed, there is some applicability to southeastern Ohio because Lake Hope, in Vinton County, has experienced an HAB and there are other large, freshwater bodies in Athens County that may have a HAB given the necessary ingredients.

The State of Ohio Hazard Mitigation Plan Draft 2019 states, “The Ohio Sea Grant Program states Harmful Algal Blooms (HAB) are caused by a combination of warm water temperatures (above 60 degrees Fahrenheit) and high concentrations of phosphorus in the water. Typically, a high concentration of phosphorus and nitrogen in cold weather will produce a bloom of diatoms, in cool weather we would expect a bloom of green algae, and in warm weather we often see blue-green algae.

One of the main focuses on reducing the number of HABs is to reduce the amount of phosphorus, which is one of the three major components in most fertilizers, followed by nitrogen and potassium. Phosphorus entering natural water ways is a major issue in the state. In Lake Erie, more than 65% of the phosphorus that causes HABs comes from agricultural fertilizer and manure runoff. Some phosphorus also comes from sewage treatment plants, combined sewer overflows, water treatment plants, cleaning products, faulty septic tanks and residential lawn fertilizers. The largest phosphorus load, about 80-90%, happens during heavy rain storms when fertilizer and other phosphorus sources are quickly washed into rivers and streams that flow into Lake Erie.

HABs can produce toxins that are capable of causing illness and sometimes even death. Microcystin is the most concerning toxin as it causes skin rashes, GI problems and varying degrees of nervous system, liver and kidney damage. While most healthy adults recover from

contact with the toxin, it can be more problematic to children, the elderly and people with pre-existing conditions that weaken their systems. Exposure has also killed people in other parts of the world. The toxin can also be fatal to pets that drink or come in contact with contaminated water.”

2.4.3 Hydraulic Fracturing

Drilling for oil and gas has been an extractive industry in Athens County since the nineteenth century. The natural gas boom of this century is due to advancing technology that allows for hydraulic fracturing to be used on a large scale. Hydraulic fracturing is the fracturing of oil and gas bearing bedrock by the injection of a mix of water, sand, and chemical additives under high pressure. This fracturing releases the bound-up gas and oil and allows for extraction.

The SOHMP Draft 2019 states, “Some citizens and local governments are becoming aware and concerned about the potential environmental and societal impacts of drilling activity in their communities. The primary concerns noted in “Drilling for Natural Gas in the Marcellus and Utica Shales: Environmental Regulatory Basics” by ODNR & OEPA dated January 2014 are:

- The possible impacts of brine or flowback water on ground water resources
- The hydraulic fracturing fluid compositions and their possible health effects
- Increased road traffic and higher road maintenance costs
- Method of disposal for the brine, hydraulic fracturing fluid and other substances related to the drilling
- Possible increase in seismic activity from injection wells
- Possible increase in air pollution from the drilling related activities”

The State Plan goes on to say, “As the number of oil, gas, and injection wells in the state increases, so does the potential for environmental impacts. The state is mitigating this risk by enhancing regulatory and monitoring programs for well drilling and waste disposal operations. Additional information on these efforts can be found at the ODNR Division of Oil and Gas website: <http://oilandgas.ohiodnr.gov/>. The state’s direction will be to continue to take steps to ensure that oil and natural gas development benefits the citizens of the state and does not adversely impact human health and the environment.”

Athens County will continue to monitor drilling activity in the area and will continue to address citizen concerns that surface around deep well injection of hydraulic fracking fluids that takes place at a deep well injection site in southeastern Athens County.

2.4.4 Climate Change

Climate change is defined by the National Oceanic and Atmospheric Administration as a non-random change in climate that is measured over several decades or longer. The change may be due to natural or human-induced causes. The SOHMP Draft 2019 says, “While the impacts of climate change may vary by regions and jurisdictions throughout the state, it is clear that the potential consequences of climate change will have significant impacts on all the citizens of the state.” The State Plan stresses the need for local governments and local institutions to prepare

for more intense storm-related problems such as flash flood drainage issues. Utilities also need to be prepared for more intense weather-related hazards.

Climate Change: A non-random change in climate that is measured over several decades or longer. The change may be due to natural or human-induced causes.

Global Warming, now more commonly referred as Climate Change has altered climatic normality well out of historic proportion. The primary cause of climate change is an increase of heat-trapping (greenhouse) gases in the atmosphere. The increased heat contained in the atmosphere has disrupted the earth's circulatory pattern. The three cell pattern (Polar, Ferrel, and Hadley Cells) as depicted in the image below, works much like atmospheric cogs to keep thermal distribution in balance between polar and equator extremes. The increase of greenhouse gasses have allowed for the Hadley Cell to expand poleward.

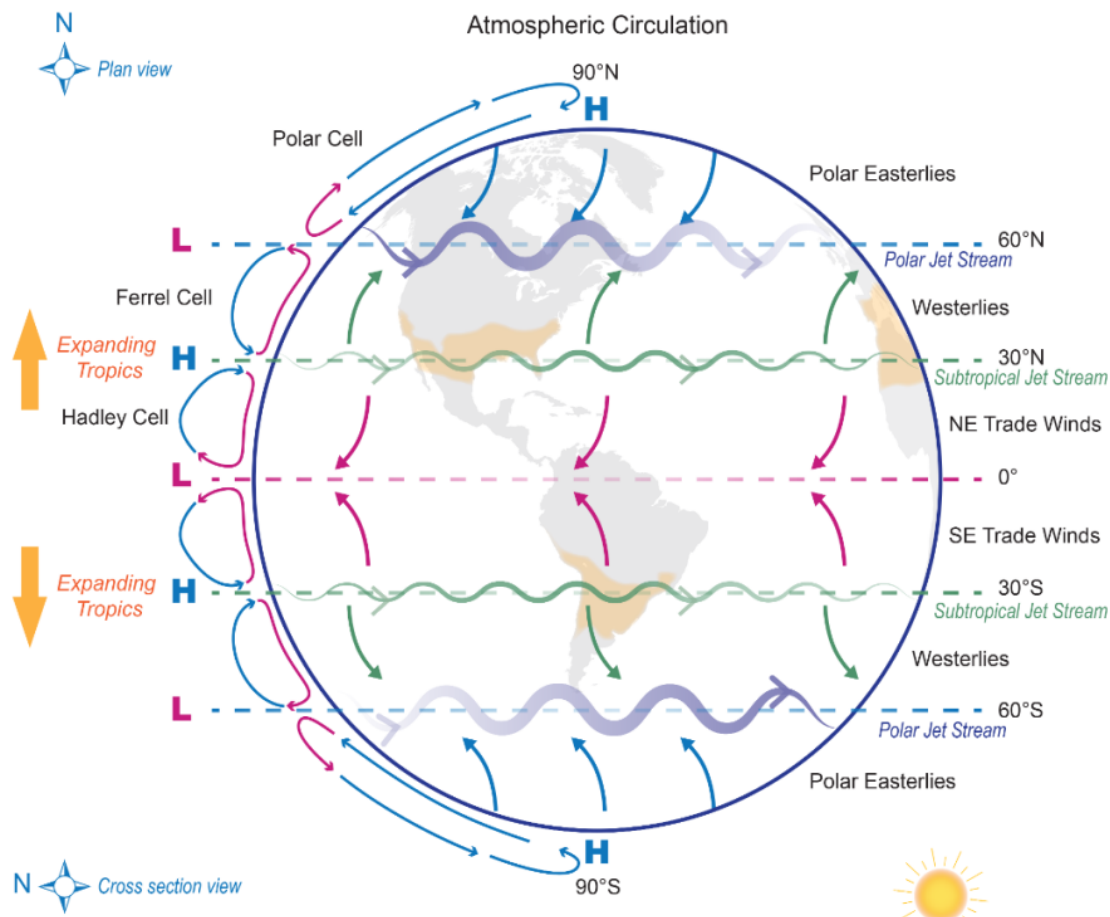


Figure 5 Atmospheric Circulation

The Hadley Cell's poleward expansion has disrupted earth's semi-permanent pressure systems across the globe and brought increased water vapor poleward in both hemispheres. The combination has altered storm track normality and annual climatic precipitation amounts. The results across the nation are geographically defined due to direct alteration of semi-permanent pressure systems and their geographic source regions. The following image collectively defines both geographic and climatic impact seen across the nation.

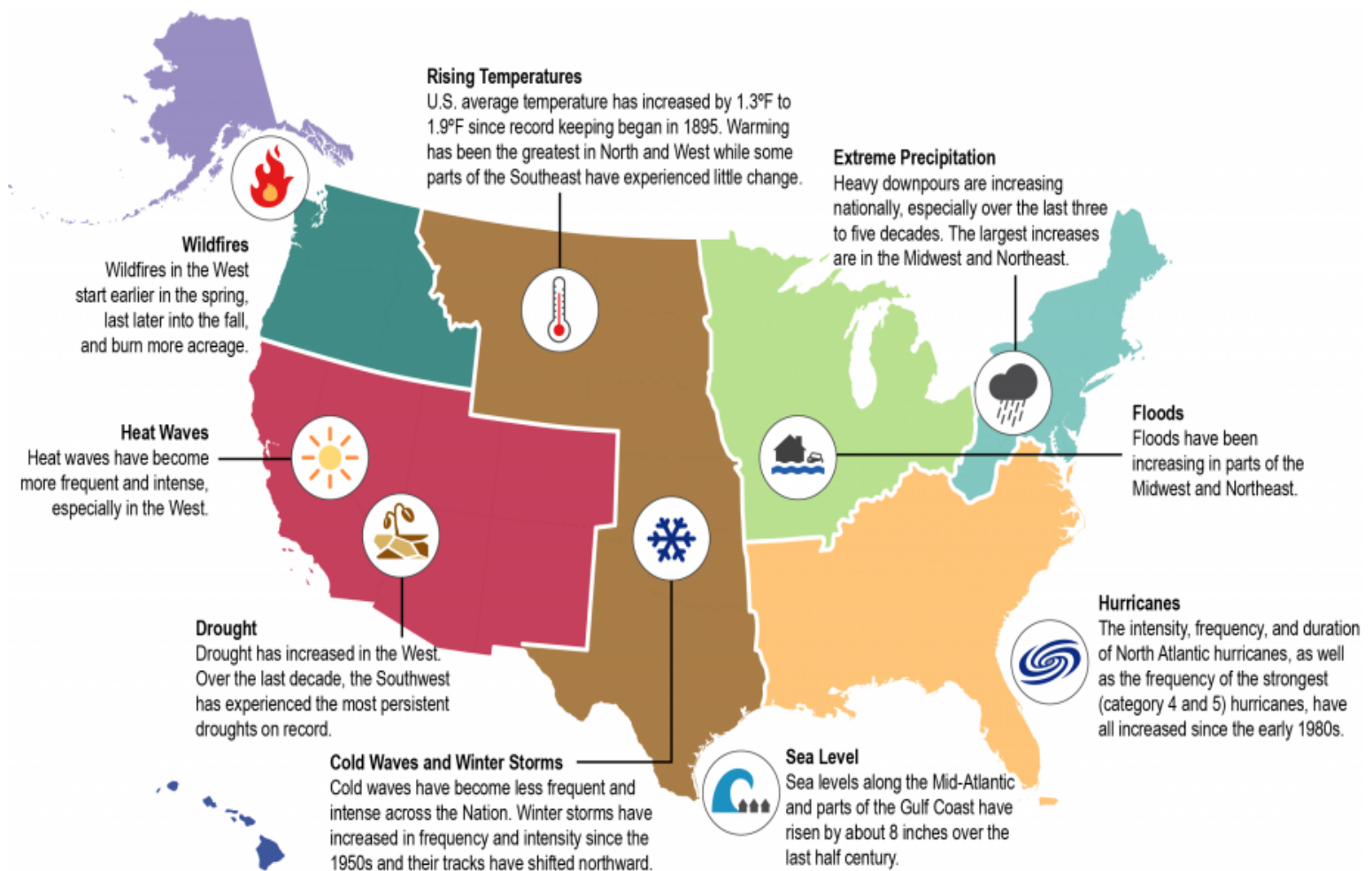
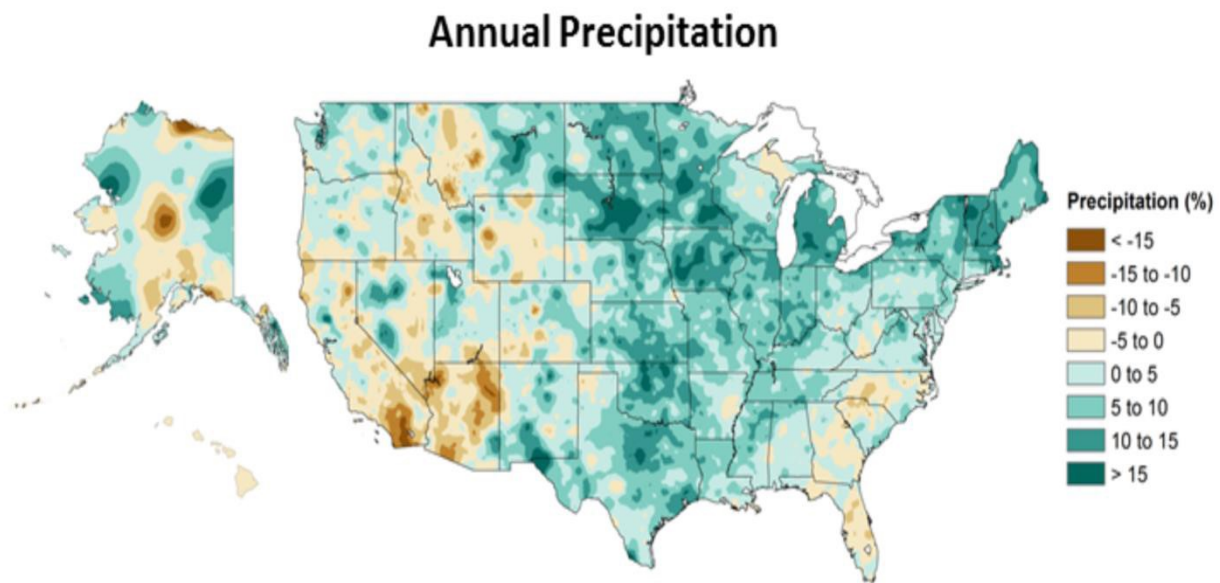


Figure 6 Climate Impact Across the Nation



Map 10 Annual Precipitation

Nationally, annual precipitation has decreased in much of the West, Southwest, and Southeast, and increased in most of the Northern and Southern Plains, Midwest, and Northeast. As a whole, a national average increase of 4% in annual precipitation has occurred since 1901, Mostly a result of large precipitation increases in the fall season.

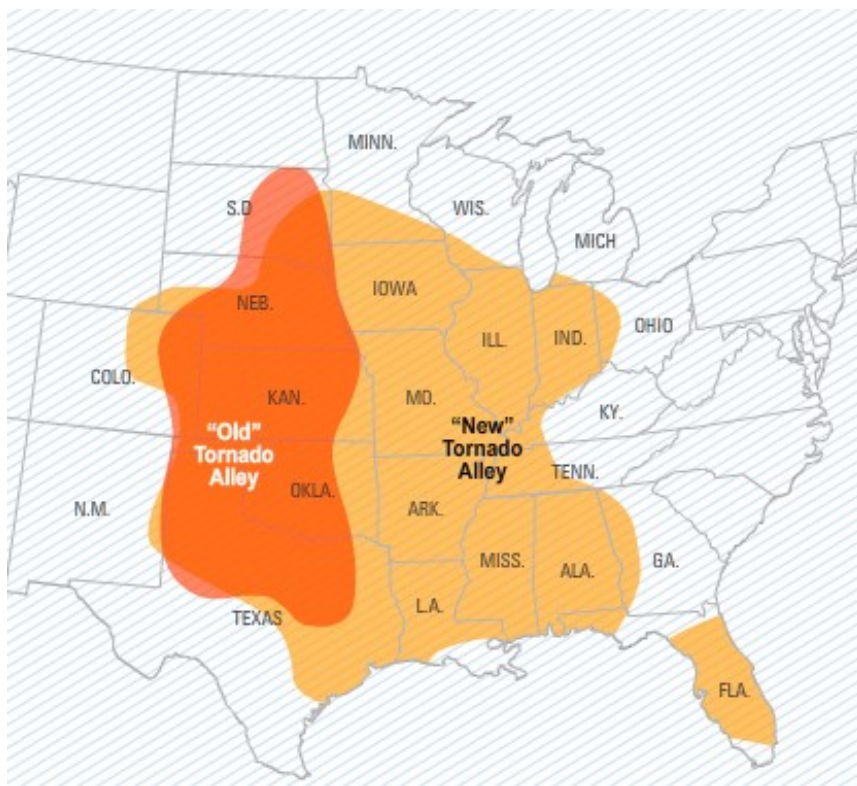
Ohio, which has only experienced about a one degree (F) warming in the last century has experience most of climate change in the form of increased precipitation. According to a study conducted by the EPA, most of the Midwest has seen an annual increase of 5 to 10 percent in the last half century. But rainfall during the four wettest days of the year has increased about 35 percent, and the amount of water flowing in most streams during the worst flood of the year has increased by more than 20 percent. During the next century, spring rainfall and average precipitation are likely to increase, and severe rainstorms are likely to intensify. Each of these factors will tend to further increase the risk of flooding.

Beyond obvious impacts of flooding to a community, the excessive rainfall amounts in the spring and fall has rendered many older storm water systems antiquated. Their volume capacity is now undersized due to excessive rainfall and water shed amounts received. This of course contributes to or compounds flash flooding effects.

Climate change has brought other local risk. Ohio is experiencing increased pressure from invasive plant and insect species. Both can alter Ohio's eco-system and threaten human health through disease transmission and allergic reaction as well as impact Ohio's agriculture vitality. Ohio's agricultural seasons may be at further risk due to rapid advancement of its phenological state, such as early plant gestation and migratory waterfowl. Climate change may also bring a reduction in quality of sensitive crops, reduced chilling hours needed for production, or the lack of needed frost season for certain crops to gestate.

Athens County, with its diverse and rugged Appalachian topography, coupled with sedimentary composition of Pennsylvanian and Permian (southeast corner) geologic periods, has not been immune to climate change. This combination of clay underneath the topsoil layer is prone to hillside slippage during high precipitation periods. In recent years, Athens County has seen increased monetary loss due to such slippages impacting the road system.

As with much of the state, many of Athens County's storm water detention systems are antiquated and undersized. Their inability to handle current water shed amounts has resulted in further erosion from overflow effects. Many jurisdictions have experienced clay tile systems collapsing from superfluous water volume, contributing to accelerated road erosion from overspill.



Climate change has also altered and increased the size of Tornado Alley. The intrusion of tornado alley into western Ohio has elevated likelihood of tornado occurrence in Athens County. Undoubtedly, one of nature's most hazardous and violent storms, tornadoes threaten the unprepared and unprotected. However, through a myriad of warning systems, sub-terrain sheltering, proper education and response, tornadoes bring more material damage than life loss.

Map 11 Tornado Alley

To conclude, climate change has brought new concern and hazards to Athens County. It's imperative that Athens County takes pro-active measures to mitigate damage inflicted by climate change. The old adage, "we have always done it this way" no longer applies. Within the past decade, climate change has proven to be formidable and deep reaching.